POWER PLANT ENGINEERING

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Modernizing Old Plants

HIGHER EFFICIENCY OF MODERN EQUIPMENT JUSTIFIES EXPENSE OF REPLACING OLD APPARATUS IN RUN DOWN PLANTS

IN SPITE of the tremendous advances during recent years in power plant design and methods of operation, it is surprising to note in traveling through the country the large number of old plants operating under conditions which are anything but conducive to high efficiency. The equipment one finds in some of these plants was obsolete years ago and while it may have been economical of operation at the time of installation, it certainly is not economical according to present day standards. When one scans the technical literature of today and notes the efforts of engineers, manufacturers and societies to promote better conditions and higher economy, one is inclined to wonder why such conditions continue to exist in any plant. In these days when boiler efficiencies of from 77 to 83 per cent are common, when water rates of 10 lb. per kw.-hr. are within the bounds of possibility and with talk of 88 to 90 per cent overall boiler efficiencies by the use of pulverized coal, one is curious to know why many owners still persist in wasting from 5 to 25 per cent of every ton of coal they buy; especially when they are compelled to pay anywhere from four to seven dollars per ton for that coal.

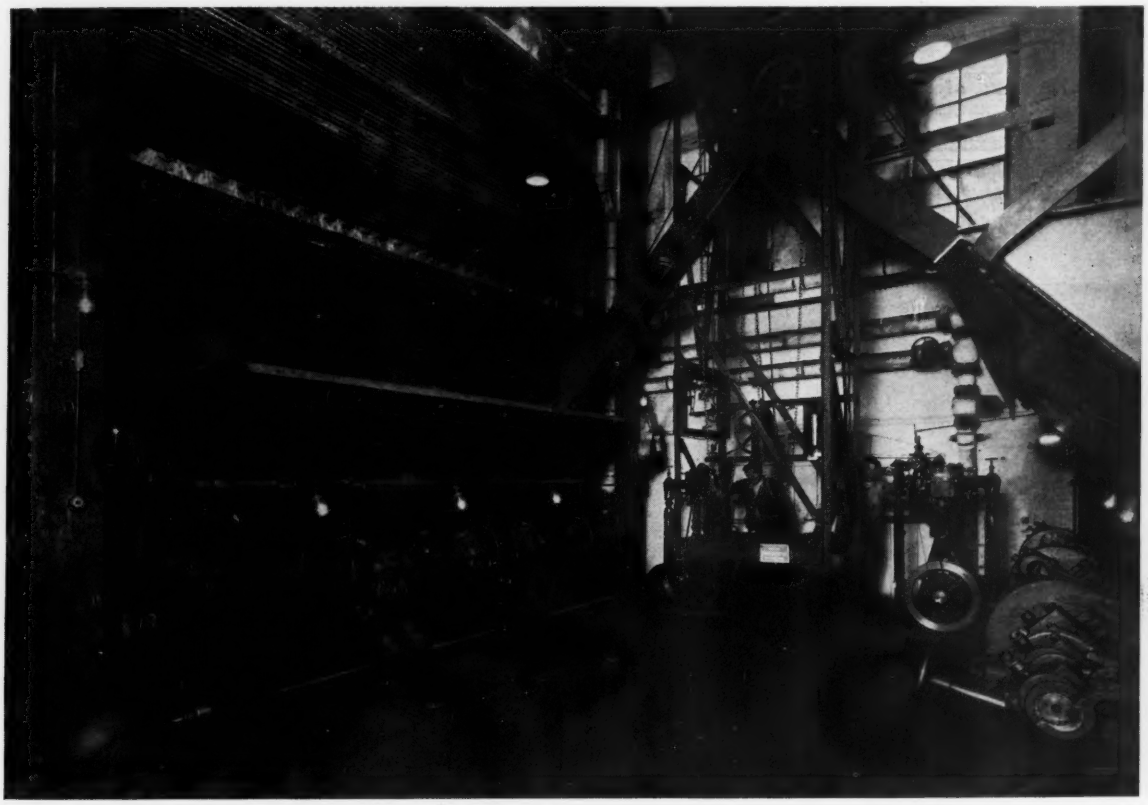


FIG. 1. BOILER ROOM OF TERMINAL HEATING AND FREEZING CO. PLANT, SHOWING NEW BOILER AND COAL HANDLING INSTALLATION

Ask these owners, and many will take you out to the

engine room and point to an old clanking slide valve engine and say, "That old girl has been running for 20 yr. and there's nothing wrong with her. She's good for another 10 yr." All of which may be true and it is not the purpose of this article to argue the point, yet the criterion by which efficiency was measured 20 yr. ago was different from what it is today. While the engine may be just as efficient as it was the day it was installed, that is no reason why, in view of the efficiencies available with modern equipment, the machine should not be discarded.

be shown, in black and white, that the cost of modernizing their plants would be saved in anywhere from 4 to 15 or 20 yr. by the increased efficiency of modern equipment and methods. The owners or managers are often men with good business ability but are usually so engrossed in the manufacturing side of the industry that little thought is given to the power plant, and as a result, the plant is often in a deplorable condition.

To illustrate what may be accomplished in the way of modernizing such plants, by the installation of up-to-date equipment, reference will be made to a few actual

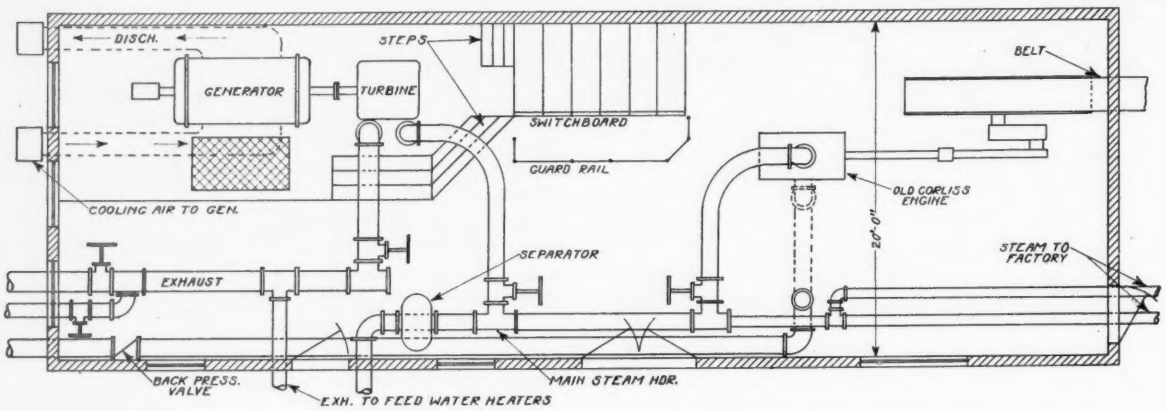


FIG. 2. PLAN SHOWING LOCATION OF APPARATUS IN ENGINE ROOM SHOWN IN FIG. 3

This argument, of course, cannot apply in all cases. There are many old-time installations, which have been kept, more or less up-to-date by the constant efforts of the engineer in charge, where the cost of discarding the old equipment and installing new would not be warranted by the slight increase in efficiency obtained. In

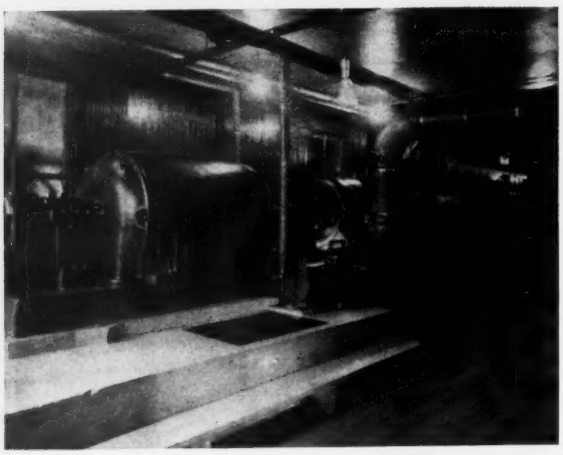


FIG. 3. VIEW IN ENGINE ROOM OF LA PORTE WOOLEN MILL, SHOWING NEW TURBINE AND SWITCHBOARD

time the depreciation fund will automatically replace the old equipment in these plants with new.

While financial considerations are no doubt largely responsible for the antiquated condition of the plants under discussion, is it probable that the existence of these conditions would be short lived if the owners could

cases. The plants referred to were both in a more or less run-down condition and the improvements made resulted in considerable savings.

Modernizing a Textile Mill Plant

The first case is that of a plant serving a moderate sized textile mill in the middle west. Due to lack of care, it had deteriorated until every piece of equipment was operating almost at the breakdown point. The boiler plant was in fairly good condition, being equipped with three 410-hp. Kroeschell water-tube boilers, fitted with Green chain grate stokers. The stack serving these boilers, however, was a low antiquated brick affair, and was unable to provide sufficient draft for good operation.

The engine room, on the other hand, was in a deplorable state; the equipment was obsolete and had served its time and purpose long years back.

Two old engines decorated the floor, one a 250-hp. Allis-Chalmers, Corliss unit of bygone vintage and the other a 25-yr.-old 80-hp. simple Corliss unit, which was belted to a line shaft in the mill. The 250-hp. machine was connected to the factory system through 1100 ft. of 1¼-in. rope transmission and was also belted to a 75-kw. direct current generator. Electricity was used in the mill only for lighting purposes; all machinery being driven mechanically as stated above. The 250-hp. Corliss machine had a 20-ft. flywheel and this together with the other equipment in an engine room only 60 by 20 ft. in size, and about 15 ft. in height left little room for comfort. To get around, the engineer no doubt must have been somewhat of an acrobat.

About two years ago, however, an addition was built to the mill buildings and as a consequence more power

was needed. For obvious reasons, this additional power could not be obtained from the power plant in its then present condition, and after due consideration, it was finally decided to install new equipment and to generate electricity for power purposes in the mill.

The old 250-hp. Corliss was dismantled and a new turbo-alternator ordered. This was an Allis-Chalmers unit rated at 500 kw., 3600 r.p.m., 240 v., three-phase, 60 cycles, and was direct connected to a 750-hp. Kerr turbine. The new machine was installed in place of the old Corliss engine, on part of the latter's old foundation. The concrete of which the old foundation was constructed, however, due to being soaked with oil and grease, had disintegrated and crumbled. It was, therefore necessary to remove about two feet of the old foundation before building the new foundation upon it.

A new six-panel switchboard was installed along one side of the engine room as shown in Fig. 3. In addition to the electric power delivered by the turbo-generator,

FIG. 4. NEW STACK AND COAL HANDLING EQUIPMENT AT LA PORTE WOOLEN MILLS

provision has also been made for taking power from the lines of the local public service company. Two sets of busses are, therefore, provided, and all feeder switches are of the double throw type. Throwing the factory feeder switches to the upper contacts, connects the load with the city service mains, while if they are thrown to the lower contacts, the load is carried by the generator.

The 80-hp. simple Corliss unit is still in operation, but the new turbine has given such satisfaction and occupies so little space, that the old engine will be replaced as soon as possible by another turbine.

In the boiler room, a new Godfrey coal conveying system was installed and the old stack replaced by a new 200-ft. concrete chimney. Since its erection there has never been any trouble due to draft, although the load on the boilers has increased 100 per cent.

The accompanying photograph shows the engine room as it is today. The turbine occupies only a small amount of floor space and considering the limited

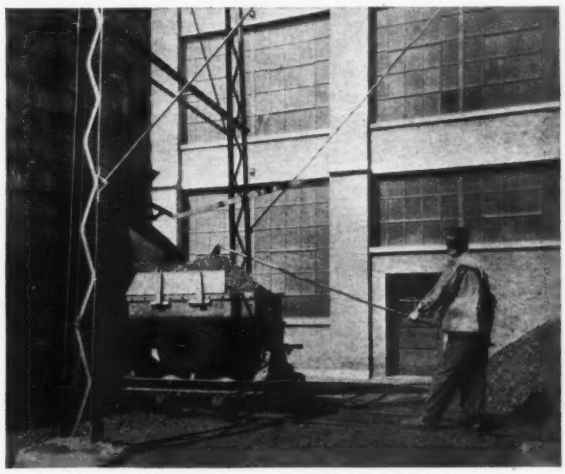


FIG. 5. METHOD OF FILLING COAL CARS FROM CONCRETE STORAGE BIN AT LA PORTE MILL PLANT

amount of space available, the room is neat in appearance. The management is well pleased with the new installation and the power plant is now being regarded

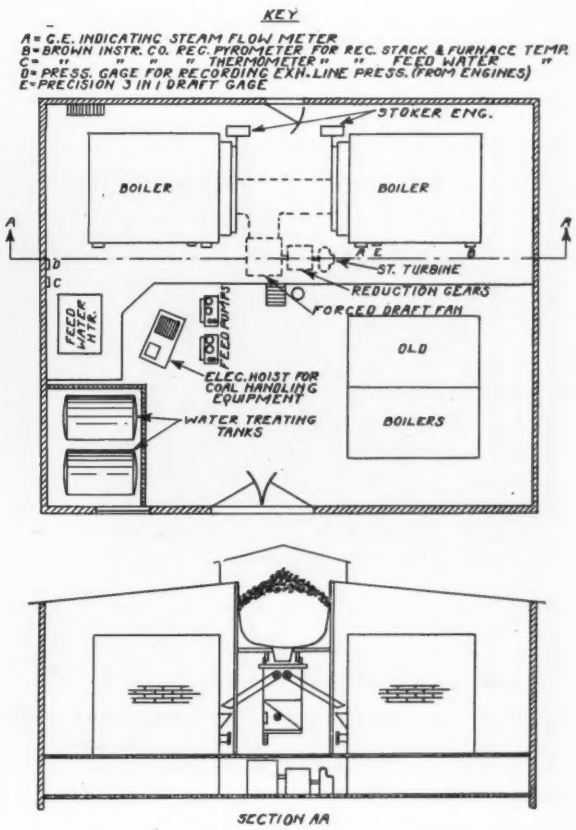

KEY
A= G.E. INDICATING STEAM FLOW METER
B= BROWN INSTR. CO. REC. PYROMETER FOR REC. STACK & FURNACE TEMP.
C= " " " THERMOMETER " " FEED WATER "
D= PRESS. GAGE FOR RECORDING EXH. LINE PRESS. (FROM ENGINES)
E= PRECISION 3 IN 1 DRAFT GAGE
STOKER ENG.
BOILER
BOILER
ST. TURBINE
REDUCTION GEARS
FORCED DRAFT FAN
FEED WATER HTR.
FEED PUMPS
ELEC. HOIST FOR COAL HANDLING EQUIPMENT
WATER TREATING TANKS
OLD BOILERS
SECTION AA

FIG. 6. PLAN OF BOILER ROOM SHOWN IN FIG. 1

as a part of the mill rather than as an undesirable necessity.

Two Boilers Replace Eight

Figure 1 shows a view in a modernized boiler plant serving a heating and freezing system in Baltimore. In this case two, 1000-hp. Edge Moor, water-tube boilers equipped with 10-retort type Taylor stokers, replaced eight old hand-fired boilers of from 450 to 500 hp. capacity each. The two new boilers not only carry the

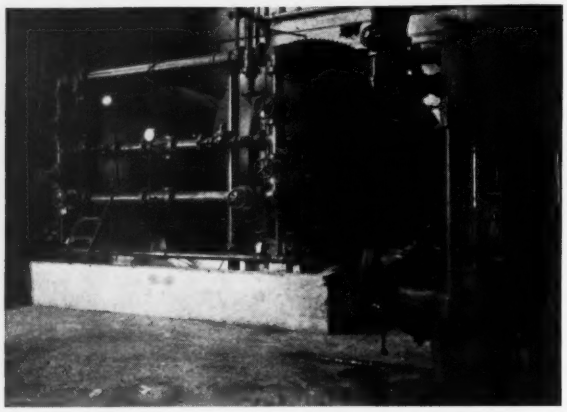


FIG. 7. NEW WATER TREATING APPARATUS

entire load that was formerly carried by eight boilers, but they are operated at a much higher efficiency.

Previous to the time of remodeling, the boilers were arranged in two rows of four, one row on each side of the firing aisle. Coal was wheeled in from an adjacent yard and dumped in the center of the firing aisle, from where it was shovelled into the furnaces. Ashes was

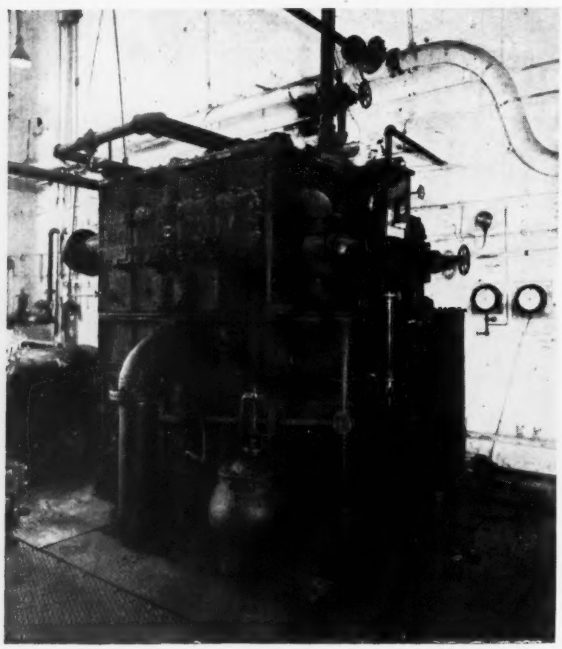


FIG. 8. NEW FEED WATER HEATER AND RECORDER

pulled from the ash pits into the firing aisle and wheeled away in barrows. Obviously, these conditions of operation were not conducive to neatness, especially when there was usually one or more boilers down for repairs. The feed water to the boilers was not treated and trouble was experienced with scale; boiler tube replacements were necessary at frequent intervals. Due to the entire absence of automatic equipment, the cost of labor was excessive and was a determining factor in the total cost of operation.

The management was fully aware of the unfortunate state of conditions existing at this plant, and was highly desirous of making improvements. It being a public service corporation, as regards the central heating system, there were difficulties in the way of securing the necessary capital to make the improvements. The price of equipment, also, was sky high, and things drifted along for a few years without any action being taken.

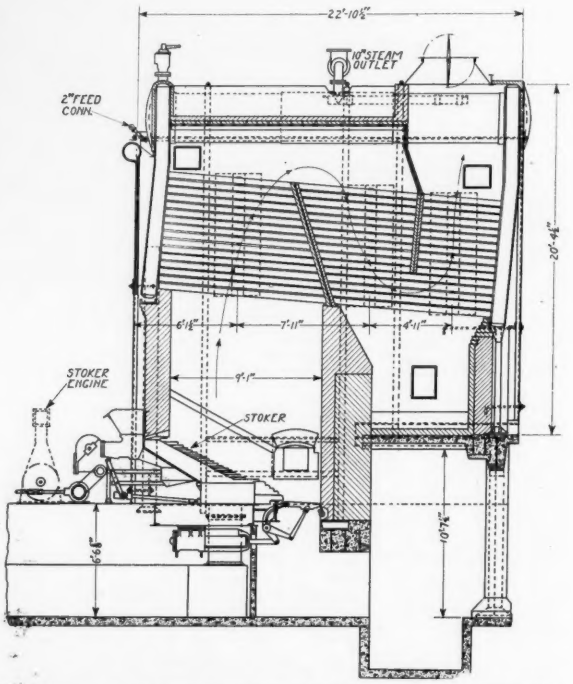


FIG. 9. TYPE OF NEW BOILERS INSTALLED IN THE TERMINAL HEATING AND FREEZING CO.'S PLANT

In the meantime the plant deteriorated rapidly, and it appeared almost hopeless to attempt to modernize it.

Early in 1921, however, prices of power plant equipment declined and the management lost no time in taking advantage of this fact. Orders for new boilers, stokers, coal handling equipment and water softening apparatus were placed with manufacturers and the work of modernizing started a short time afterwards.

A plan of the boiler room as it is today is shown in Fig. 6. The Permutit water treating apparatus is shown in Fig. 7. The firing floor at the two new boilers is constructed of steel floor plates and is set about 7 ft. above the old floor. This allows of the forced draft blowers to be placed beneath it and at the same time provides space for the convenient removal of ashes at the rear of the boilers.

Coal is delivered into a hopper adjacent to the boiler house and after passing through a crusher is elevated by a skip hoist and delivered into the overhead coal bunkers. A weigh larry receives coal from the bunkers and delivers it to the stoker hoppers.

The stokers are driven by two 6-in. by 7-in. Troy vertical engines through a line shaft as may be noted in the accompanying photograph. A banjo regulator governed by the pressure in the forced draft ducts controls the speed of the stoker engines.

Feed water is treated by the Permutit apparatus, shown in Fig. 7, is heated in a Cochrane feed water heater having a capacity of 200,000 lb. per hr. and is delivered to the boiler by either of two vertical, duplex feed pumps. The latter were part of the old equipment and only required overhauling.

Each of the two new boilers is equipped with the following instruments:

1 Precision 3-in-1 draft gage.

1 General Electric Co. indicating steam flow meter.

1 Brown recording thermometer for stack and furnace temperatures.

1 Indicating steam pressure gage.

In addition to the instruments on each boiler there is installed, one Brown recording thermometer, for feed water temperature; one Brown recording pressure gage for steam pressure and a Cochrane recording V notch meter on the feed heater.

Two of the old boilers have been retained and are located as shown in Fig. 6. These will be equipped with stokers and will be used as spares when it becomes necessary to overhaul one of the new units.

Since the plant has been remodeled cost of operation has undergone a considerable reduction and conditions have been greatly improved. The management was so certain of the success of the result of work that they made a 20 per cent reduction in rates even before the new equipment was put into operation, and subsequent operating performance has fully justified this reduction.

When operating at one-half rated capacity an evaporation of 9.5 to 10 lb. of water per pound of coal is obtained, the coal having a heat content of about 13,700 B.t.u.

Due to the effectiveness of the water treating apparatus, trouble due to scale has been entirely eliminated and tube replacements are practically unknown. Although the summer load is comparatively small, there have been occasions when the two boilers have been operated at 260 per cent load without the slightest difficulty.

While the instrument installation is not of an elaborate nature, it will be noted sufficient units have been installed to afford the keeping of all ordinary operating records. No CO_2 apparatus is provided but it is planned to install suitable meters for CO_2 determination in the near future.

First Cost Not Determining Factor

The foregoing furnishes an excellent example of what may be accomplished by the investment of a comparatively small amount of money. Previous to undertaking a remodeling project of this nature, a thorough study should be made of existing equipment in order to determine which to discard and which to retain. It must be kept in mind that labor, these days, is an item of considerable expense and any method or machine which will reduce the labor cost should be given the preference. It may require the investment of a considerable outlay of capital, but the return due to savings effected will in most cases justify the investment. While first cost must be given due consideration at all times, it must be remembered that operating cost is the all important factor governing profit and loss, and a judicious outlook of the proposition from this point of view will usually indicate the correct solution to any particular problem.

Possibilities of High Pressure and Superheat for Steam Turbines

A Theoretical Discussion of the Problems from the Standpoints of Constant Heat Content, Constant Temperature, and Constant Pressure. By J. A. Polson

CONSIDERABLE interest exists in regard to increased pressure and increased superheat for use in steam turbines.

In this article a study will be made based on the properties of steam for various pressures and superheats, omitting all discussion of the effect on boilers or boiler efficiency and the effect on piping and fittings.

It will also be assumed that, for the sake of comparison, changes that may occur in the steam due to throttling, wiredrawing and reheating will have a somewhat similar effect on practically all turbines. It will therefore simplify the discussion by limiting the study to a more or less ideal case.

In the steam turbine, the potential energy in the steam at the initial condition of high pressure and temperature but low velocity is changed into kinetic energy at lower pressure and temperature but at higher velocity. Assuming the initial velocity low as compared with the final velocity and neglecting all losses, the final velocity of the steam discharging from the nozzle is:

$$(1)\quad w = \sqrt{2GJ(i' - i'')}$$

where w is the velocity in feet per second

G is the acceleration due to gravity = 32.2

J is the mechanical equivalent of heat = 778 ft.-lb.

i′ and i″ are the initial and final heat content of the steam.

Substituting the values for G and J and reducing

$$(2)\quad w = 223.7\sqrt{i' - i''}$$

In the ideal case, the same results will be obtained whether we assume the entire increase in velocity to take place in one nozzle or in several.

The difference in the values of i′ and i″ depend on the heat contents at beginning and end of the expansion. That is, the difference depends not only on the high pressure at entrance but also on the exit pressure from the nozzle. The exit pressure is then the same as the pressure in the condenser and that may be as low as ½ in. of mercury absolute based on 30 in. barometer. It will be realized that practically no further gain can be made by reducing the vacuum. Adiabatic expansion at constant entropy is assumed in all cases.

The comparison will be made on

I. Constant heat content per pound, the pressure and temperature varying.

II. Constant temperature, the pressure and heat content varying.

III. Constant pressure, the temperature and heat content varying.

TABLE I. PROPERTIES OF STEAM AT CONSTANT TOTAL HEAT CONTENTS

Total Initial Heat Content, (i') 1250 B.t.u. per lb. of Steam.						
Initial Conditions				Final Conditions		
Absolute Pressure	Total Temp. F.	Superheat	Entropy	Dryness	Heat content i"	Heat Drop i' - i"
Col.(1)	(2)	(3)	(4)	(5)	(6)	(7)
150	456	98	1.634	0.775	847	403
200	468	86	1.600	0.761	851	419
300	491	74	1.560	0.740	810	440
400	513	68	1.53	0.725	795	455
500	533	66	1.511	0.714	783	467
600	552	66	1.496	0.705	773	477
700	568	65	1.477	0.698	766	484
800	585	67	1.465	0.692	759	491
Heat Content (i') 1300						
150	549	191	1.667	0.80	874	426
200	558	176	1.656	0.785	858	442
300	577	160	1.618	0.764	836	464
400	594	149	1.583	0.749	821	479
500	610	143	1.560	0.738	809	491
600	625	137	1.541	0.729	799	501
700	638	135	1.526	0.722	791	509
800	652	134	1.511	0.714	785	517
Heat Content (i') 1350						
150	645	287	1.733	0.823	898	452
200	652	270	1.705	0.808	882	468
300	666	249	1.658	0.785	859	491
400	679	234	1.628	0.772	844	505
500	690	223	1.604	0.759	831	519
600	702	216	1.585	0.750	821	529
700	712	209	1.569	0.743	813	537
800	724	206	1.555	0.736	806	544
Heat Content (i') 1400						
150	745	387	1.778	0.845	922	478
200	750	368	1.746	0.830	905	495
300	760	343	1.698	0.806	880	520
400	768	323	1.670	0.793	865	535
500	776	311	1.646	0.780	852	548
600	787	301	1.627	0.771	843	557
700	797	294	1.611	0.764	835	565
800	805	287	1.595	0.755	827	573

TABLE II. PROPERTIES OF STEAM AT CONSTANT TEMPERATURES

Initial Temperature				Constant at 500 deg. F.		
Initial Conditions				Final Conditions		
Absolute Pressure	Total Temp. F.	Superheat	Entropy	Dryness	Heat content i"	Heat Drop i' - i"
150	142	1.661	1274	0.787	860	414
200	118	1.623	1268	0.769	841	427
300	83	1.568	1255	0.743	815	442
400	55	1.523	1241	0.720	790	451
500	33	1.486	1226	0.701	770	456
600	14	1.452	1211	0.686	752	459
700	Sat	-	-	-	-	-
800	Sat	-	-	-	-	-
Temperature Constant at 600 deg. F.						
150	242	1.712	1326	0.813	888	438
200	218	1.677	1322	0.797	870	452
300	183	1.626	1313	0.770	843	470
400	155	1.587	1304	0.752	822	482
500	133	1.554	1294	0.736	804	490
600	114	1.526	1284	0.723	791	493
700	97	1.500	1273	0.709	777	496
800	82	1.477	1261	0.697	765	496
Temperature Constant at 700 deg. F.						
150	342	1.757	1377	0.856	913	464
200	318	1.724	1374	0.816	892	482
300	283	1.675	1369	0.791	868	501
400	255	1.638	1362	0.776	851	511
500	233	1.609	1356	0.762	835	521
600	214	1.584	1348	0.747	820	528
700	197	1.561	1341	0.738	808	533
800	182	1.541	1333	0.728	798	535
Temperature Constant at 800 deg. F.						
150	442	1.799	1428	0.855	932	496
200	418	-	-	-	-	-
300	383	1.719	1422	0.816	891	531
400	355	1.685	1418	0.799	873	545
500	333	1.657	1413	0.785	858	555
600	314	1.633	1408	0.774	846	562
700	297	1.612	1403	0.764	836	567
800	282	1.594	1397	0.754	826	571
Temperature Constant at 900 deg. F.						
150	-	-	-	-	-	-
200	-	-	-	-	-	-
300	483	1.759	1475	0.836	912	563
400	455	1.726	1472	0.818	894	578
500	433	1.699	.469	0.806	880	589
600	414	1.676	1465	0.796	869	596
700	397	1.657	1461	0.785	858	603
800	382	1.640	14 57	0 . 777	850	607

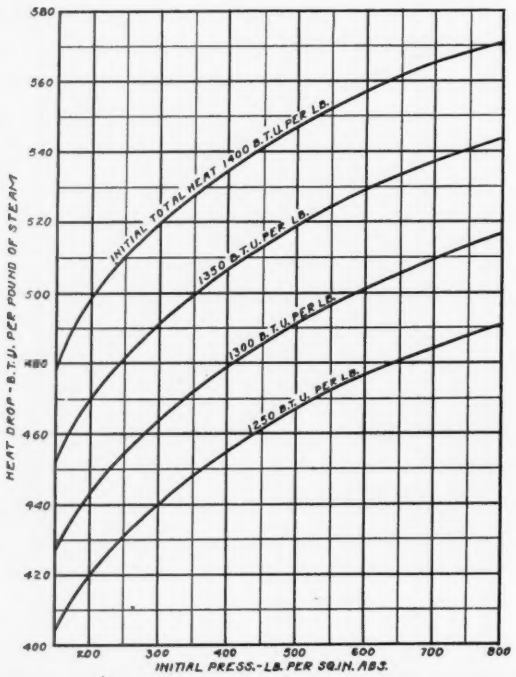


FIG. 1. CURVES SHOWING VARIATION OF HEAT DROP WITH HEAT CONTENT

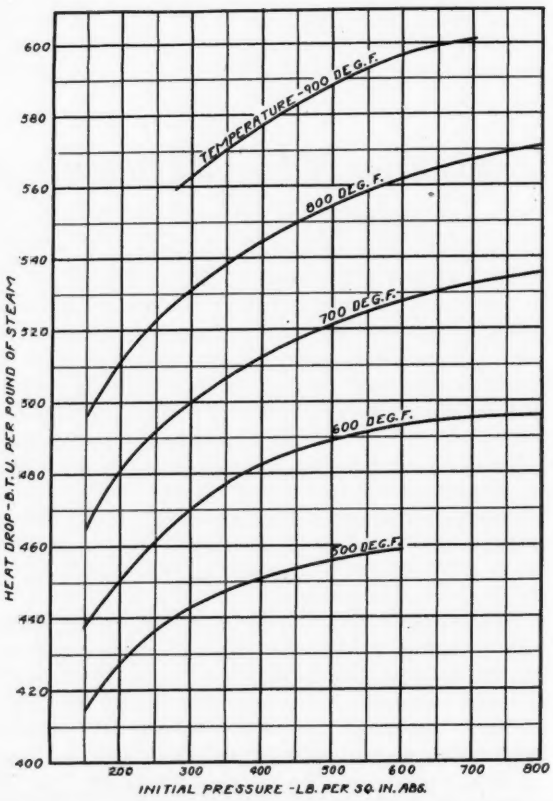


FIG. 2. CURVES SHOWING VARIATION OF HEAT DROP WITH TEMPERATURE

Goodenough's Steam Tables have been used in preparing this article.

Constant Heat Content

Table I gives some of the properties of steam at constant total heats of 1250, 1300, 1350 and 1400 B.t.u. per lb. at the initial conditions of pressure and temperature. Thus steam containing 1250 B.t.u. per lb. at 150 lb. per sq. in. absolute pressure must be at a temperature of 456 deg. F. This shows the steam is superheated 98 deg. F.

In this article it is assumed that the steam expands adiabatically at constant entropy to a final absolute pressure of ½ in. mercury. In Col. 5 the dryness of the steam is given when it has expanded to the final pressure. In Col. 6 is given the heat content in B.t.u. per lb. of steam at the final condition and in Col. 7 the difference between the initial and final heat contents or heat drop.

The curves in Fig. 1 illustrate even better than the table how the "heat drop" increases as the pressure increases also as the initial heat content is higher. A study of these curves shows that there is still a decided upward slope of all the curves at 800 lb. pressure, showing that the heat drop would be still greater for higher pressures.

The question of thermal efficiency or Rankine efficiency will not be discussed in this article.

The curves, however, show that for every 50 B.t.u. added to the total heat there is an approximate increase in heat drop of 26 to 28 B.t.u., i. e., the curves are nearly parallel.

TABLE III. PROPERTIES OF STEAM AT CONSTANT INITIAL PRESSURES

Temperature	Initial Conditions: Entropy	Initial Conditions: Heat content 1'	Final Conditions: Dryness	Final Conditions: Heat content 1"	Heat Drop 1' - 1"
Initial Pressure Constant at 200 Lb. Absolute					
400	1.559	1210	0.732	808	402
500	1.623	1288	0.766	841	427
600	1.677	1322	0.790	869	453
700	1.724	1374	0.816	893	481
800	1.768	1425	0.841	916	509
Initial Pressure Constant at 300 Lb. Absolute					
500	1.567	1255	0.742	818	443
600	1.625	1314	0.768	842	472
700	1.675	1369	0.791	868	501
800	1.719	1422	0.816	891	531
900	1.759	1475	0.836	912	562
Initial Pressure Constant at 400 Lb. Absolute					
500	1.524	1241	0.721	790	451
600	1.586	1304	0.755	822	482
700	1.638	1362	0.777	849	513
800	1.684	1418	0.799	873	545
900	1.726	1472	0.819	894	578
Initial Pressure Constant at 500 Lb. Absolute					
500	1.486	1227	0.702	770	457
600	1.554	1295	0.735	805	490
700	1.609	1356	0.763	834	522
800	1.656	1413	0.788	858	555
900	1.699	1469	0.806	880	589
Initial Pressure Constant at 600 Lb. Absolute					
500	1.453	1211	0.687	752	459
600	1.526	1284	0.722	790	494
700	1.584	1348	0.750	820	528
800	1.635	1408	0.775	846	562
900	1.677	1465	0.796	869	596
Initial Pressure Constant at 700 Lb. Absolute					
500	-	-	-	-	-
600	1.500	1273	0.708	777	496
700	1.561	1341	0.739	809	532
800	1.612	1403	0.764	835	568
900	1.657	1461	0.793	859	602
Initial Pressure Constant at 800 Lb. Absolute					
500	-	-	-	-	-
600	1.477	1252	0.698	765	487
700	1.541	1333	0.729	799	534
800	1.596	1397	0.755	826	571
900	1.640	1457	0.778	850	607

Constant Temperature

The condition of constant initial temperature presents a different aspect to some extent. Table II has been arranged to show the properties of steam for various pressures when the total initial temperature was kept constant at 500, 600, 700, 800 and 900 deg. F.

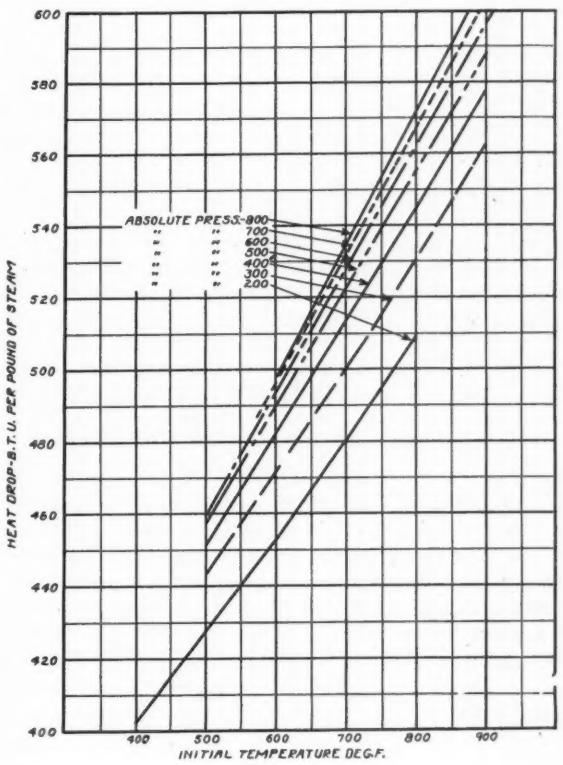


FIG. 3. CURVES SHOWING VARIATION OF HEAT DROP WITH PRESSURE

The heat drop in B.t.u. per lb. is shown in Fig. 2 for various pressures and constant initial temperatures. The curves are plotted on the same scale as those in Fig. 1. They show that the slope is not so great at the higher pressure and for a temperature of 600 deg. there is no increase to be gained by pressures higher than 700 lb. The gain in B.t.u. heat drop is approximately the same for each 100 deg. rise in temperature for the same pressure, but it increases with higher pressure.

Constant Pressure

Table III is arranged to show the properties of steam for initial constant pressures of 200, 300, 400, 500, 600, 700 and 800 lb. at temperatures from 500 to 900 deg. F. This is shown graphically in Fig. 3. Here it is seen that the slope of the lines is not the same and that they are not parallel, but come nearer to each other as the pressure increases. This shows that for any given temperature the increase in heat drop diminishes as the pressure is increased until very little would be gained by increasing the pressure to 900 or 1000 lb. unless the temperature was also raised for the higher pressure.

It will be realized that the same heat drop may be secured by several combinations. Referring to Fig. 2,

it will be seen that a heat drop of 560 B.t.u. per lb. of steam may be gotten from steam at 300 lb. pressure and 900 deg. temperature or from steam at 570 lb. pressure and 800 deg. temperature; as another example, 520 B.t.u. heat drop may be gotten from steam at 235 lb. pressure and 800 deg. temperature or 485 lb. pressure and 700 deg. temperature.

All the curves show that there is a possible gain in heat drop for pressures considerably higher than are in use today, at least from the ideal standpoint. It is well known that the heat drop will be decreased in the actual case because of reheating of the steam caused by friction of various kinds and therefore the gain will be less than indicated; however, if no gain were possible in the ideal case no gain would be possible in the actual case.

To the uninitiated, it may seem that the dryness and the final heat content should be practically constant because the final absolute pressure of ½ in. mercury is taken as constant for all cases. Referring to the tables, it will be seen that the final heat content varies from 752 to 932 B.t.u. per lb. and the dryness from 0.686 to 0.845, a difference of 180 B.t.u. in heat content and 0.159 in dryness.

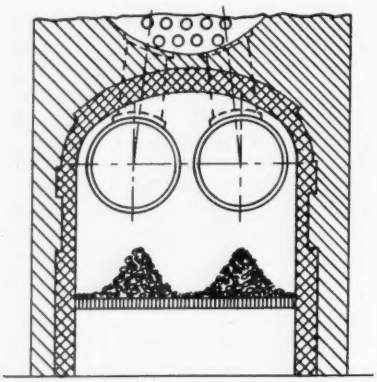
It is well to call attention to the low dryness or high moisture present in the steam at the final pressure. When steam expands to a constant final pressure, the moisture at the final pressure will increase as the initial pressure increases at constant total heat or constant temperature. This large amount of moisture, approximately 32 per cent, would be apt to cause trouble unless special provision was made for drainage between stages.

If the initial temperature is increased at constant initial pressure, the moisture at the final pressure will decrease and the steam be more dry. The heat given up by the steam when moisture is formed is the latent heat of vaporization and is very high at low pressures. It will therefore produce a greater heat drop by increasing the pressure at constant temperature than by increasing the temperature at constant pressure.

Meeting Abnormal Calls for Steam

THE USE OF CONICAL FUEL BEDS ENABLES THE FIRE AREA OF THE FURNACE TO BE INCREASED WITHOUT INCREASING THE GRATE AREA. BY ZUCE KOGAN

THE ABILITY of steam generators to meet abnormal calls for steam is a matter of great importance in most steam plants, but particularly so in plants serving large factories such as sugar refineries whose demand for steam is large and of an intermittent nature. A sugar refinery may be carrying a perfectly normal load with the steam at the proper pressure for carrying on the process work, yet a few moments later a sudden demand for a large quantity of steam may tend to reduce the pressure to ⅔ of its normal value; in fact,



ILLUSTRATING THE CONICAL METHOD OF FIRING FOR MEETING ABNORMAL CALLS FOR STEAM

the drop in pressure may at times be so severe that the resulting pressure will be insufficient to operate some of the apparatus connected to the system. This obviously results in great loss in the economy of apparatus, for much loss of time and labor.

Of course, it is evident that any such drop in pressure due to sudden demand for steam may be insured against by the provision of adequate boiler capacity to meet the emergency, but this means a greater investment in equipment as well as increased maintenance costs. Another method by which this question may be solved is in the use of grates that will permit responding to the irregularities in the demand for steam.

It is well known that the larger our grate area the more steam a given boiler will be capable of generating and this would lead us to install very large grates. Considering, however, in this case the question of grate-area from a more fundamental point of view, we must abandon the faulty expression of grate area and use instead its correct meaning which is fire area. We cannot take the exact area of our grates to be the exact area which generates the steam. It would be incorrect, for instance, to consider the area of the traveling continuous-chain belt-grate to be the grate area used for combustion, since some portion of the grate is used in covering the thickness of the furnace walls and the space for the hopper. Considering another case by supposing an ordinary grate, a certain portion of which had to be covered with brickwork, in order to fulfill better the requirements of the fuel, draft, etc., we would certainly not consider the original grate area as being effective in producing combustion. On the other hand, it is as faulty to consider the grate area to be the fuel-bed area. The author's experience with high-moisture fuels such as bagasse has convinced him of the fact that the fuel bed area is not the grate area, for, in burning fuels of this kind, part of the grate area is covered by fuel which is not burning but which is being dried by the heat of the furnace. The part of the grate so covered is obviously not effective in producing combustion. It will, therefore, be more to our purpose to speak of increasing the fire area and not the grate area for meeting the abnormal calls for steam.

This principle has already been employed to a certain extent by combustion engineers, but those systems have produced somewhat uneconomical working conditions.

Some manufacturers, for example, have patented and made use of draft chambers under the grates so

that when there is little demand for steam some of the draft chambers are closed while the fuel is fed as usual. This method may be said to be uneconomical, due to the fact that some of the fuel is without draft on the grate while it is subjected to the intense heat of the boiler furnace, thus obliging a portion of the non-drafted fuel to burn in the form of CO. But leaving this question, as it is well known that a sufficient supply of draft is necessary to any fuel if its economical utilization is required, we come to the need of increasing the fuel area itself. Taking, for example, an ordinary horizontal grate where the fuel bed is spread uniformly over its surface, and the draft supplied throughout the whole surface under the grate, the steam generated would be directly proportioned to the fire area on the grate. If, however, we increase or decrease this fire area on the same grate area, the steam to be generated will increase or decrease accordingly. In practice, this principle has been applied successfully through charging the fuel bed in conical forms as shown in the accompanying illustration. In this case, the fire area is increased without any other changes being made. Moreover another great advantage is obtained, due to the fact that the fire projected from the conical surfaces is more dense than that of the horizontal surface of fuel bed. The denser fire produced by the conical sides of the fuel bed means more calories per given section of flame, and a more intense heating of the boiler furnace for the generation of steam. The increase in fire area by this method helps to meet the abnormal calls for steam, yet this is obtained without an expensive installation, the process being simply to charge the fuel to higher or lower heights of cones. The only change required in boiler installation is in the combustion chamber, which has to be much larger than with ordinary feeding system, and which varies with the desirable height of cones, and the particular kind of fuel. Another important question that is to be carefully considered is the skill necessary for feeding the fuel in this manner. The air, as is well known, takes the passage of least resistance, and in this case the cone will make a difficult passage while the lower portion of fuel bed will give an excessive passage of draft, which results in unsatisfactory combustion of fuel. For this reason, it is necessary to charge the conic or the high fuel beds with large size coal, and the lower beds with smaller sizes. The proportion of the sizes of coal to be fed on the different fuel levels varies with many factors, but in practice this may be easily found by noticing which condition gives the highest CO_2. The feeding, however, will depend absolutely on the skill of the fireman. The most important advantages with such a system of firing are that it is the cheapest, it obviates the need of expensive stokers which are usually required for such purpose, and it gives the possibility of meeting a considerable variation in steam demand.

Steam Turbine Lubrication and Operation---I

A Discussion of the Problems Involved in the Correct Lubrication of the Steam Turbine. By Thomas A. Brown

BECAUSE OF the severity of conditions imposed by steam turbine service and due to the complicated requirements for a suitable lubricant for this class of work, the lubricating problem is probably the most important confronting those responsible for turbine operation today. While in a large number of cases systems of lubrication and grades of lubricant have been produced which fulfill the requirements and conditions of the problem in general, the numerous instances of trouble experienced by a great number of operating companies indicate a decided lack of knowledge of the subject.

The need for specifications setting forth the physical and chemical characteristics of oils for use on steam turbines has long been recognized and various attempts have been made in the past to discuss this problem and to bring a number of technical bodies to an agreement regarding the uniformity of scientific methods of testing petroleum products.

Under this subject turbines should be classified as to method of application of the lubricant. Some turbine bearings are lubricated by pressure circulation systems, others by drop feed oilers on plain bearings and ring or collar oiling bearings. Those turbines that have a set of reducing gears included in their design employ drop feed, ring and collar oiling, splash and circulation methods of application of lubricating oil.

On direct connected turbines, it is common practice to find the smaller size units used for driving centrifugal water pumps, small generators (about 300 kw. and under) blowers, etc., equipped with other methods of application than a circulation system.

In direct connected units, 500 kw. and larger, the pressure circulation system is almost universally used. A pressure circulation system is one that supplies a proportionately large volume of oil under pressure of 3 lb. to 15 lb. to each bearing. In some units this pressure is supplied and controlled through the adjustment of a baffle valve and oil is taken from the governing system which operates at from 70 to 90 lb. pressure.

The smaller size turbines with ring oiled bearings require an oil of such characteristics that it will not be too light in body to meet the very high temperature of the bearings adjacent to the cylinder. Because of their close proximity to the steam casing, there are found temperatures in the neighborhood of 190 deg. to 220 deg. F. caused by induced heat. As this induced heat is constant, it is incorrect to argue that lubrication can be improved by a reduction in operating temperature of these bearings. This same lubricant, however, would be unsuitable for the driven unit, as there would probably be found normal bearing temperatures.

Great care should be given to the selection of the oil for the two bearings usually known as No. 1 and No. 2 bearings (numbering from the steam end) which operate at these unusually high temperatures.

If the turbine is exposed to outdoor temperatures during the winter season and is operated intermittently, the oil suitable for these bearings will congeal at temperatures of about 40 deg. F. As these bearings are

usually ring oiled type, the congealed oil would not be carried up by the rings, the bearing would suffer for lack of a lubricant, and the result would be a burned out bearing or a seizure.

Lubrication of Geared Units

Little is known of the operation of geared units. They have rapidly come into use for many purposes during the past 5 or 6 yr. Progress on these units has been retarded because of lack of knowledge of gear design, coupled with the use of crude machinery used in machining these gears. Special tools had to be designed and built for accurate cutting of such gears. Today, however, gears for high speed work up to 16 ft. in diameter are cut with very small tolerances as to variation.

The gear case design has also had a very important bearing on this development. In some geared units the gears are lubricated by the same pressure circulation system that supplies oil to the bearings, in which event the oil spray is directed toward the point where the gears mesh, preferably on the ingoing side.

In this instance the lubrication of the bearings is by force of conditions subordinated to the lubrication of the gears.

An oil suitable for the bearings alone may not be suitable for the gears, as the gears may require a lubricant of far different characteristics. An oil suitable for the gears can be used, however, for bearing lubrication, but not with the ultimate good results that could be secured with an oil better suited for bearing work only.

The real function of the lubricant in this case is gear tooth protection and on this point the operator is very often mistaken as to the so-called "satisfactory" operation of the gear sets. Apparently they are operating without noise or trouble until some day after several years' running an inspection shows considerable wear and flaking of the surface of the teeth on the side on which work is being done. This is the result from the use of an incorrect lubricant.

Figures 1 and 2 are illustrations slightly enlarged of pieces of teeth broken out of a turbine driven gear set showing the smooth side on which no work has been done, and the opposite side which shows wear and flaking due to the use of an incorrect oil. When the teeth of this gear set were inspected, they showed real "pinning" on the edge of the work side of the tooth. The photograph was taken about two years later, after the unit had operated about 50 per cent of the elapsed time. A pressure circulation system was in use which was so designed that a correct oil for gear lubrication could not be used in it.

On this question of gear lubrication, it is surprising the lack of knowledge generally found. Recently, when visiting one of the very large automobile manufacturers, a 500 kw. geared turbine was observed. On inquiry, it was found that a lubricant of incorrect physical characteristics, to say nothing of its quality, was in use and this in the face of a very decided recommendation of a correct oil both as to quality and characteristics which the builder insisted the user furnish for starting up.

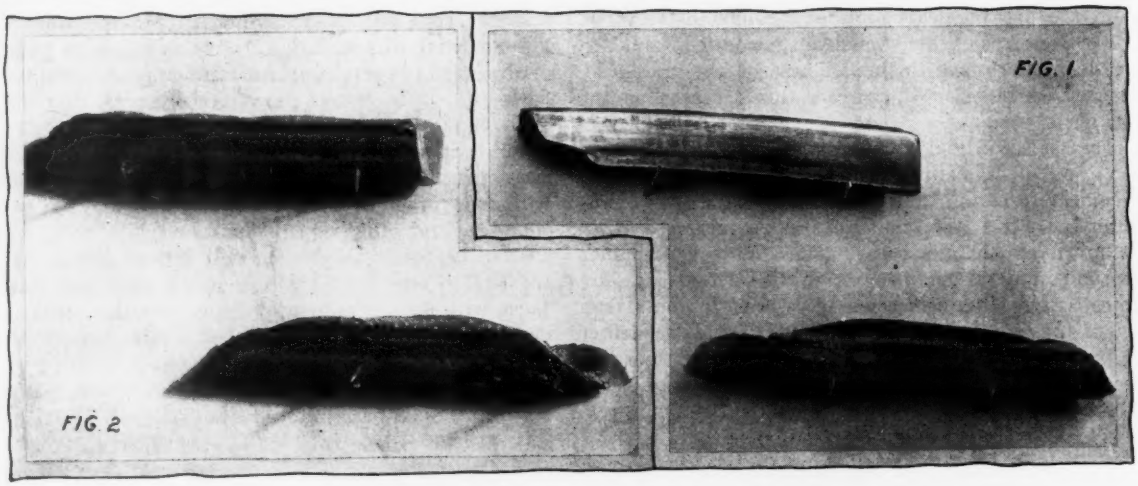


FIG. 1. PIECES OF GEAR TEETH BROKEN OUT OF A TURBINE DRIVEN GEAR SET, SHOWING SMOOTH SIDE ON WHICH NO WEAR HAS TAKEN PLACE. FIG. 2. OPPOSITE SIDE OR SIDE ON WHICH WORK HAS BEEN DONE, OF GEAR TEETH SHOWN IN FIG. 1. NOT E WEAR AND FLAKING DUE TO USE OF INCORRCT OIL.

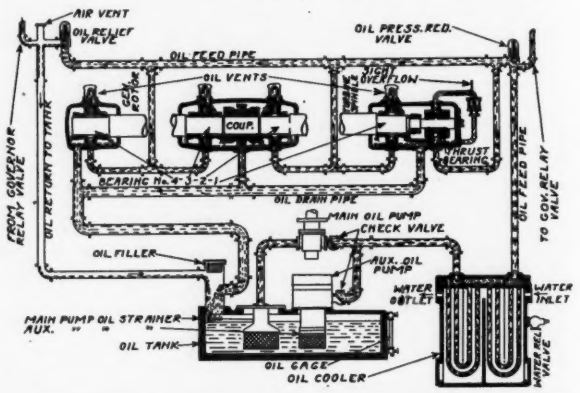


FIG. 3. A TYPICAL STEAM TURBINE LUBRICATING SYSTEM

Some gears are lubricated by a splash system, that is, the larger gear is permitted to dip in the lubricant, carrying and throwing it to all gear tooth faces.

With such system lengthy experience has shown that too high an oil level will cause a very high operating temperature of all parts. Usually, the correct level is obtained when it reaches a point equal to the level of the inside of the rim when the gear is at rest.

It is often surprising to the lubricating engineer to note the chances taken by operators and concerns of a supposedly high type of organization on the subject of lubrication. There is a general knowledge of steam engine lubrication as to the kind of lubricant for cylinders and bearings. This is probably due to the length of time this type of unit has been in use and because these conditions are usually not difficult to meet. But the subjects of turbines, gears, internal combustion engines and air compressor lubrication are not nearly as well understood, and any of these units can be ruined in a short time by the use of an incorrect oil.

Pressure Circulating Systems

When considering direct connected turbines served with a pressure circulating system, we should divide these in two classes:

(1) The smaller sized turbines, usually 2000 to 2500 kw. or less, are served by the oil system for the lubrication of bearings only. The capacity of the system is 35 to 50 gal. or less. The governor is direct acting, not as in,

(2) which class includes all the larger sized machines where the oiling system may be a part of the governor control, or where larger volumes of oil are used in the system supplied.

In one type the oil pump, which is driven by a worm gear drive form the main shaft, raises the oil to a pressure of 70 to 90 lb. and from this higher pressure the oil is passed through a baffle valve to the bearings at a pressure of 2 to 15 lb.

In both of the above-mentioned classes the lubricant is subjected to very severe service; in fact, the oil is subjected to all the elements which go toward the depreciation of its value. These include high temperature (usually induced heat) causing oxidation, contamination from water and rapidity of circulation.

Small Turbine Units

In the smaller units, the temperature of oil leaving the bearings will rarely run as low as 140 deg. F., and sometimes as high as 205 deg. F. The period of circulation (reservoir capacity divided by pump capacity per minute) is somewhat less than a minute and is rarely higher than two minutes. These two conditions rapidly produce oxidation or breaking down of the oil, about which more will be said later. From the viewpoint of the lubricating engineer, there are two remedies which will considerably modify these strenuous operating conditions, i. e., increase the reservoir capacity and increase the cooling capacity of the system.

It is recognized that both of these improvements would add to the manufacturing cost of units, but it would also result in a more satisfied feeling on the part of the turbine purchaser, which will ultimately result in bigger business for the turbine builder.

With reference to water contamination: This is a very serious menace with certain types of oil. Its accumulation in the system is sometimes accidental, and at other times it is a question of incorrect design. The latter should be given every consideration by the builder, as the accumulation of water in the turbine oiling system may cause the shut-down of the unit, the loss of bearings or the injury to the blading and generator. With the lowering of the oil value due to the high temperatures and rapid circulation, even with the highest type of lubricant in use, there will be emulsification or thickening of the oil if water collects in the system, and machine failure will result.

The use of an incorrect lubricant on some of the smaller sized machines has resulted in higher temperatures than those which were normally produced by the induced heat. Speaking specifically because of the high operating temperature, the use of an oil heavy in body (about 250 viscosity at 100 deg. Saybolt) was recommended, the theory being that this heavy bodied oil would be thinned down by the high temperature to the point where it was suitable. In practice, however, this did not work out for the fluid friction within the oil itself produced a higher temperature than normal.

It has, furthermore, been discovered that the lighter bodied oil (about 135 viscosity at 100 deg. Saybolt) would better withstand the severe treatment of high temperature, oxidation and water contamination, with no difficulty as regards bearing lubrication because of the oil being too light in body.

Large Turbine Units

With reference to the second classification, that is, the larger machines as mentioned previously, the problem is somewhat different than in the smaller sized machines. Here the reservoir capacity may be as high as 1200 gal. and the temperature of oil discharge from the bearings will sometimes run as high as 185 deg. F. On the very large sizes, 10,000 kw. and over, the speeds are usually 1500 to 1800 r.p.m. On some of these units, the oiling system also takes care of the governing operation, which governing is handled by what is simply a hydraulic cylinder with a pilot valve control, opening and closing a valve or valves for admission of variable quantities of steam according to the load.

This system has been mentioned as one of the controlling factors on the selection of a lubricant, which fact cannot be agreed with by the writer. Its function is purely hydraulic, and as oil is a non-compressible liquid, there can be no influence on its operation based on the characteristics of the oil used. There is, however, on units of this class, an influencing factor in the capacity of the oil pumps, usually centrifugal in design. These pumps are designed with a very high factor of safety as to quantity, any excess quantity being taken care of by a relief valve that permits the superfluous quantity to return to the reservoir. If these pumps were of smaller capacity and still within the bounds of safety, there would be an increased period of circulation which would result in greater opportunity for the oil to settle.

With large units there is a thrust bearing problem that has at times influenced some engineers to recommend a heavy bodied oil to better handle this point, and in the final analysis really is an attempt to correct a mechanical difficulty with oil, which is, at all times, poor engineering. If at any time thrust bearing trouble develops to the extent of burning out, it is well to look into the mechanical condition of such a bearing, as well as into the matter of an ample supply of oil.

Thrust bearings are designed with a large factor of safety as to unit bearing pressures, and do not require any *special* consideration as to the kind of lubricant to use. The oil discharge from the thrust bearing is usually 15 deg. to 25 deg. higher than the oil discharge from the bearings.

Oil Engine Hints

LUBRICATION, OIL AND BEARINGS. BY BERT BARE

PROPER and economical lubrication of oil engines has been in most cases and still is in some cases, a problem of first importance. In the case of the low compression engine using crankcase compression and scavenging, the criticism operators often make is that the engine uses more lubricating oil than it does fuel oil. This may be an exaggeration, but it shows that there is a condition that requires watching on the part of the engineer. The fundamental idea in lubrication, as it is called, is really keeping the temperatures of the rubbing surfaces down below that at which they would soften and burn out. The function of the oil is to reduce the friction and thereby the heat generated, to a minimum; but if the finest bearing material and the very best lubricating oil were used and the bearing so insulated that the little heat generated could not properly radiate, the bearing would heat up and burn out.

LUBRICATING SYSTEM

IN THRUST bearings of the horseshoe type, the horseshoes are water-cooled and the more efficient the cooling the greater the load the bearings can carry without trouble. In the Kingsbury thrust bearing, the oil reservoir is cooled by water circulating in pipes set in the reservoir. For engine lubrication, there are three general methods that are used. There is the circulating oiling system where the lubricating oil is supplied under a constant pressure of from 15 to 25 lb. per sq. in. Oil ring lubrication and forced feed or mechanical lubrication are also used. The oil ring method is used only in stationary practice, either one of the others being used in marine work.

The best method is the circulating oiling system. An ample supply of oil is pumped to the main bearings, whence the pressure carries it to the crankpin and through the connecting rod to the wristpin. In this way the bearings are kept supplied not only with enough oil to maintain the oil film in the bearings, but also with enough oil to cool them effectively. The oil finds its way to the engine base from all the lubricated surfaces and is then pumped through cooling system and a filter so that it is ready to repeat the cycle. Where this system is used, it will be well to have thermometers at the inlet and outlet connections so that any rise in the temperature can be detected. If the temperature of the oil as it comes from the engine rises above its normal value, a glance at the thermometer of the oil as it leaves the engine, will tell where the trouble is. If the inlet temperature is normal, it means that some bearing or part is becoming unduly heated and the cause should be immediately located. If the temperature of the inlet oil is also rising, the trouble will probably be in the oil cooling part of the system.

In marine engines the changes of cooling water temperatures are sometimes quite abrupt and a rise in the cooling water temperature will be followed by a rise in the temperature of the cooling oil. This sudden change in temperature is due to traversing different ocean currents and since the location of these are known, the engineer will be able to know when it is necessary to watch for a change in temperature.

In all cases the cylinders will need to be supplied with mechanical lubricators, as the oil has to be forced to its place under high pressure. Care must be exercised in the selection of a mechanical lubricator as some of the older types will not be able to stand up to the pressures required of them. Special mention should be made to the oiler manufacturer that the lubricator is to be used for Diesel engines.

LUBRICATING OIL

OIL USED for cylinder lubrication must be of a high grade, as it has to do work under high temperatures and must be able to stand up to them. Some of this oil will find its way into the combustion space and will be burned. What oil remains will find its way into the crankcase unless provision has been made to prevent this. The oil is thick and black from carbon and should not be allowed to mix with the circulating oil where the latter is used. In the trunk piston type, a trough arrangement should be installed to catch this oil and drain it away from the circulating oil. Filters of various designs and also centrifugal separators have been used with marked success in cases where the lubricating oil has become dirty and is in quantity sufficient to warrant the installation of these reclaimers.

Lubrication of the low compression type of engine, especially where mechanical lubrication is used, requires special care on account of the criticism previously mentioned, that the consumption of lubricating oil seems unduly large. Since in this case the amount of oil supplied is used, or should be used, mainly in keeping the oil film intact, and since whatever oil is supplied is not again used, provision for radiation should be made as efficient as possible and so minimize the amount of oil consumed.

KEEPING BEARINGS COOL

WATER cooling is the best way of accomplishing this and some of the engines are so constructed that the lower half of each main bearing rests on a cooled surface. This cooling space is part of the engine bed casting and materially lessens the amount of oil necessary for the proper lubrication of the bearing. Where provision has been made for this bearing cooling, the water connection should be made so that the cold water being supplied to the engine is first sent to this cooling chamber. The amount of water so supplied should be abundant.

It will be noticed that in a number of cases no oil grooves are cut in the lower half of the main bearing shell or where they are cut in, they do not meet. The bottom of the bearing is the place where there is the greatest pressure and, if there were oil grooves at this point, the pressure would cause the oil to flow into the grooves and out at a region of lesser pressure. This would destroy the oil film or at least would tend to do so. If bearings heat up and it is thought that better satisfaction would be had by cutting grooves in the lower half of the shell, instead of making matters better, they would be made worse. Some other experiment should

be tried with the idea of preventing the oil from flowing from a region of high pressure to one of low pressure.

Where the circulating system of oil cooling is used, care must be exercised when starting up to see that oil is supplied to all parts of the engine promptly when the engine starts to turn over, otherwise the parts may burn out before the oil reaches them. A small hand pump for priming, the same as is supplied for the fuel oil, should be installed, if not already a part of the engine, and the parts should be flooded with oil before the engine starts to turn over. Check valves in the line, especially to the connecting rod, must be looked after to see that they are in proper condition. In this way, after a shut-down, oil will be supplied promptly to the parts when the engine is started up.

It is well to have the lubricating supply tank so situated that the oil flows by gravity to the circulating pump, which will insure good priming when starting up. In this case, however, it will be well to be sure that the oil from the tank is shut off when the engine is shut down because, if the suction valves leak a little, the entire supply of oil in the tank may be drained into the crankcase and there will be none ready to start up with.

Crankcase Oil

In the crankcase type of engine, lubricating oil accumulates in the base and since the clearance there is small, it is desirable to drain off this oil frequently so that it will not be churned up and be carried with the scavenging air into the cylinder chamber, where it would carbonize. Drainage is provided for by pipes connected to the bottom of the crank chamber and carried to a convenient place on the engine where valves of some sort are provided to prevent the loss of air. These valves are opened when draining and the oil will be blown out in spurts at every revolution due to pressure of the scavenging air in the crank chamber. When oil ceases to be blown out and air starts to blow, the valve should be closed. The oil that has been blown out is not good to be used again.

Main Bearings

Materials of which the main bearings are made must be of a special character to stand up to the high and intermittent pressures to which they are subjected. A special Diesel babbit or white metal combination is generally used. The material should be particularly tested for even hardness over the whole surface of the bearing, otherwise, after a little running, the harder spots will take all the wear and are liable to become heated.

Maximum pressures on the main bearings where continuous lubrication is used, will be about 400 to 500 lb. per sq. in. of projected area. When the hardness of the material, as between bearings, is different, there is a possibility over a period of time, that one of the bearings may wear more than the rest. The center bearings are the ones that are inclined to wear down quicker than the others, probably due to the fact that the end bearings have less work to do and so help support those nearest them. This dropping of one of the bearings causes high pressures or stresses in the crank shaft and is liable to be the cause of a crank shaft breakage, if not watched for and taken care of in time.

Some engines are fitted with micrometer attachments on each of the main bearing caps and when the engine bearings have been properly lined up and the caps securely fastened in place the reading of the micrometer as the screw touches the shaft is noted and recorded and thereafter, at intervals of a couple of weeks, readings are taken to see what wear, if any, has taken place. In this way the bearings can be kept up in position by whatever means of adjustment the engine is provided with. If there is no other means of adjustment, all the bearings must be scraped down to fit the lowest one. Adjustment in some cases is made with shims and in others with wedge blocks. In these cases the bearing shell is set into the adjustable block. It will be found to serve the best purpose, if the engine is taken down enough twice a year so that the bearings can be inspected for alinement.

An Interesting Trip to Study Foreign Trade Conditions

"WE WANT to trade with the world." Thus has President Harding summed up the business situation in this country. An outlet for our surplus manufactures is essential and will become increasingly necessary as we turn more of our labor power to manufacturing industries.

But to think intelligently about foreign trade we must have knowledge of foreign markets, business methods and requirements, which can best be obtained by observation and personal contact.

The International Chamber of Commerce is formed to promote this knowledge, and will hold its second general meeting in Rome, Italy, March 18 to 24, 1923. The program is not yet announced, but the most pressing of international problems will have consideration in the sessions.

In connection with the visit of the American delegation,—probably two to three hundred of the most noted business men,—to Rome, the American Section is planning a trip which will give opportunity to visit and study the principal Mediterranean countries, as well as Switzerland, Germany, Belgium, France and England. This will leave New York on Feb. 10, 1923, and return on May 5, and will be so planned that all arrangements for accommodations will be made in advance, the expense being kept as low as in consistent with first-class appointments.

Information in regard to the trip or the meeting at Rome can be had from Lacey C. Zaff, Sec'y, Mills Building, Washington, D. C.

German deliveries of coal and coke under the reparations clause, which should amount to 1,900,000 T. a month, were in deficit during the latter part of 1921, more satisfactory at the beginning of 1922, but are again far below the proper figure since the latter part of May, according to the Review of the American Chamber of Commerce in France. While it is true that coal production in Germany has diminished by 5 to 10 per cent, according to localities, it also is true that nearly all the important German coal-consuming industries, such as the metallurgy and machinery, are running at full production.

Erecting an Oil Engine

VALUABLE INFORMATION FOR THE OPERATING MAN WHO IS CALLED UPON TO ERECT HIS OWN EQUIPMENT. BY M. S. HOWARD

IN ERECTING an oil engine, or any kind of engine for that matter, the obviously first thing to do is to lay the foundations. This means excavating for the foundation, building the form to hold the concrete and finally the pouring of the concrete.

The engine builder should always furnish the wooden templet as well as the foundation blueprint, but sometimes the former is not included in the contract. It is, however, simple enough to lay out a rectangular shape of about 1 by 6-in. boards, with the bolt holes in the proper places. This templet should have marked on it the center line of the engine shaft and the center line of the pulley if it is a belt-driving engine.

The forms, for small engines, can be made by the earth walls of the excavation. If the engine is large, the walls may cave in, so it is best to have a wooden form. It isn't necessary to remove these boards after the concrete is run, for the ones above the floor are removable while those buried in the ground will do no harm. It doesn't pay to scrimp on the amount of concrete, so the foundation should be at least as large as the dimensions given on the builder's drawing. If the ground is not fairly solid, it will be necessary to make it larger. Foundations are figured to meet average conditions, and one should always remember that if the soil is "filled in" ground, a large footing is necessary.

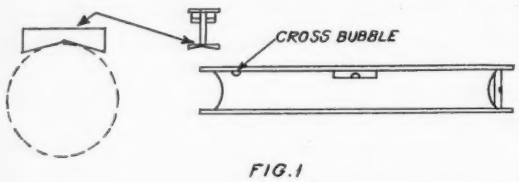


FIG. 1

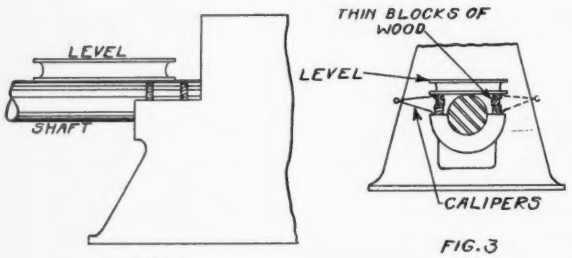


FIG 2 FIG. 3

FIG. 1. METHOD OF APPLYING THE SPIRIT LEVEL
FIG. 2. TESTING FOR LENGTHENING LEVEL
FIG. 3. TESTING FOR CROSSWISE LEVEL

The engine templet must be set level, and the shaft line parallel with the counter shaft, and the engine pulley center line must line up with the pulley to be driven. The templet must be firmly fastened in place so that it cannot be shifted. The foundation bolts should be slipped in a piece of pipe about 1 in. larger in diameter than the bolt and then hung from the templet. The foundation plan shows how high the engine bolt lugs are above the bottom so the nuts should be screwed down far enough to provide this amount of space plus about ½ in. for grouting the bed.

POURING THE CONCRETE

WHEN THE concreting is begun, it should be continued until the job is complete. If a stop of a day or two occurs, the new concrete will not tie into the older mixture. The concrete should be brought up to the level of the templet and allowed to harden a week before the engine is set on it. A mixture of 1 part cement, 3 parts sand, and 5 parts crushed rock makes good material. Since the engine shown in the accompanying sketches, as many semi-Diesels also do, draws the scavenging air from the cavity under the engine bed, the top of the foundation should be smoothed and painted before the engine is set on it. This keeps the air from picking up dust, etc. A good scheme recommended in one book on oil engines is to pour several gallons of linseed oil into this space after the engine is in place. This is probably better than painting.

LEVELING

IT IS NECESSARY to level the engine both ways. How this is done depends upon the make of engine. Some engines have a planed surface on the top of the frame to be used for leveling purposes. In other engines no such surface is handy, and the leveling must be done by the crankshaft. To do this the bearing cap next to the flywheel is removed. A spirit level similar to Fig. 1 having a cross bubble and a V-groove along one edge must be used. This is placed on the shaft so that the shaft rests in the groove. The level is shifted until the cross bubble shows level. If the engine is not level lengthwise with the shaft, the lengthwise bubble will show "out." The engine must be raised by driving in or out on the proper iron wedge. To check the setting for crosswise levelness, the level is placed across the shaft, Fig. 3, and leveled by thin blocks of wood, etc. The distance between the level and the surface of the bearing housing is measured. If the two don't agree, the engine is out of line and must be wedged up on the low side.

When the engine is level, a mixture of cement and sand, worked up with water until it flows stiffly, is rammed under the frame. This is allowed to set and then the foundation bolts are drawn up tight and the wedges are removed.

The engine is now set in its proper position and the next thing to take up is the flywheel and extended shaft. It is, of course, possible to aline the outboard bearing by means of the center line laid out on the templet, but this is not exact. A better way is to bolt the extension shaft to the engine shaft and then set the outboard bearing under it. This bearing is raised until the shaft is slightly lifted from the bottom part of the end main bearing at Fig. 4. The cap of this bearing is left off. A thin coat of red lead is smeared on the top of the journal here. The shaft is then revolved and the outboard bearing is gradually lowered until the red lead wipes away. This indicates that the bearings are now all in line.

Putting on the Flywheel

If the construction of the engine is, as in Fig. 1, such that the flywheel fits to the end of the crankshaft and the extension shaft bolts to the wheel hub, the extension shaft is removed after lining up and the wheel put on. With a one-piece wheel with a split hub, wedges are driven into the splits to expand the hub to make the wheel slip on more easily.

The flywheel on the belt pulleys is placed on the extension shaft, but keyed only lightly. After the shaft is put into place the belt pulley is shifted to make it line up with the pulley to be driven.

Fitting the Exhaust Piping

The exhaust pipe is next bolted to the engine. Usually some kind of muffler is furnished with the engine. With two-cycle engines there is a central length of pipe where the return pressure wave reaches the exhaust port at the exact time the piston uncovers the ports. This sets up larger waves just as in a musical pipe instrument, and the engine makes a great deal of noise. The pipe should be as short as possible, but in all cases over 5 ft. long. Avoid all elbows or bends possible. Use asbestos gaskets on the flanges and do not put the pipe in the concrete floor, for the expansion and contraction will break the cement. Don't permit any easily burned material to be installed close to the pipe. If the pipe is over 20 ft. long, increase the size by 2 in. from that leading from the engine to the muffler.

Fuel Piping

Next connect up the auxiliary fuel pipe, which takes the fuel oil from the storage tank to the engine fuel reservoir. See that the pipe diameter is ample, never use less than ¾-in. pipe. Use enough unions, with ground joints, to permit taking down easily. Make up all the joints with a good pipe dope. Litharge is probably best. See that the pipe slopes from the pump to the tank so that no air pockets are formed. If the pump ever fails to draw oil, it will be found in most cases that the line is air bound. To relieve this, fill the pump and line with oil and start again.

In connecting up the engine fuel pump, clean it and the piping with coal oil. Don't allow grit to get under the pump valves. Don't screw the pump stuffing-box too tight or the plunger may stick. Don't let the injection nozzle valve leak. If it does gases will enter the oil line and the pump will fail to deliver oil. This air cushion will cause the oil to flow into the engine after the pump plunger stroke is ended. This oil dribbling will make the engine pound.

If heavy oil is to be used, it must be warmed. This can be done by wrapping a coil of the oil line from the storage tank around the exhaust pipe. A good plan is to make this part a bypass so that by regulating the valve openings a certain part of the oil will flow around the hot pipe, and mixing with the rest, will warm it. This arrangement is shown in Fig. 5.

In connecting up and in running don't let grit get under the atomizer or nozzle check valve, for the action of the engine depends upon the tightness of this valve. Keep the valve ground to an airtight set and carry an extra one on hand. To test the nozzle for leaks, disconnect the oil pipe and then turn the engine back on compression. If the check leaks, air will blow out. Powdered glass and thin lubricating oil makes the best grinding compound.

The Cooling Water System

One of the requirements of a successful oil engine plant is a good cooling water system. If the water is bad it will be necessary to treat it with a chemical to set the calcium carbonate. If the temperature is kept below 140 deg., none of the other minerals will deposit. It is much better to use rain water if this is available.

In putting up the piping, both the inlet and outlet lines should slope so that they can be drained. All pockets should be avoided. The outlet from each cylinder should be separate and open so the engineer can feel the water temperature and see that all cylinders are getting a supply.

The tank should be raised so that the water flows to the pump by gravity. The best arrangement is to have a supply tank 10 ft. above the engine and a sump or pit. The pump takes water out of the sump and delivers it into the overhead tank. The water flows from the tank (which should hold 25 gal. for each engine horsepower) to the engine jacket. The water from the jacket flows into the sump. This insures a supply of water even though the pump may be out of operation for a few hours.

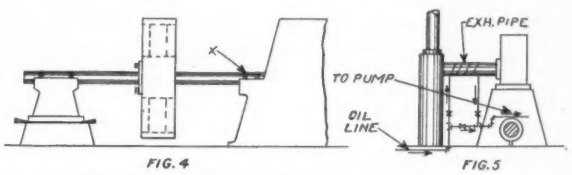


FIG. 4. ALINING THE OUTBOARD BEARING

FIG. 5. SHOWING ARRANGEMENT USED TO HEAT FUEL OIL TO ENGINE BY WRAPPING THE DELIVERY PIPE AROUND THE EXHAUST LINE

Starting Air

Most oil engines are started by compressed air. The air compressor should be belted to the extended shaft. A pulley is not absolutely necessary for the shaft will often do. The compressor can be water-cooled, but an air cooled one is simple, as it needs no water piping, and is cheaper.

The air storage tank should be capable of withstanding 200 lb. working pressure and should be plenty large. For example, a 12-in. by 5-ft. tank is the correct size for a 50-hp. engine, while an 18-in. by 5-ft. tank should be used on a 100-hp. and a 24-in. by 5-ft. on a 125—150-hp. The piping should be extra heavy and the joints made up with some sort of dope. A safety valve is always necessary and a drain should be placed at the bottom of the tank to draw off the condensed moisture.

Since this is a solid injection engine, in starting it is only necessary to work the hand pump until the oil lines are all full. The air starting lever is thrown in and the engine turned over a few times. The fuel pump is then thrown into action and the engine starts firing on one or more cylinders. The air starter is then thrown out and the air starting cylinder begins firing.

With a semi-Diesel it is necessary to heat the starting plug until it is red hot. The engine is turned over by

hand to its starting position, the cylinders are given a few shots of oil by working the hand pump. The air is turned on and the engine is turned over. As soon as the speed is up high enough, the engine starts firing. Sometimes the engine pounds and it is then necessary to hold back on the pump handle to cut down the pump stroke to reduce the oil to the cylinder.

Operating Hints

As soon as the engine comes up to speed, see that the cooling water is running and the lubricating oil supplying each point.

The temperature of the cooling water depends upon the particular engine and the kind of fuel being used. If the compression pressure is low and the fuel heavy, a temperature of about 160 deg. is correct. With high compressions a temperature of 120 deg. is best. On low loads, it may be necessary to run the temperature up to 180 deg. if steady firing is desired.

The operator should see that the rings do not stick. This is usually because of too much lubricating oil, and it should be cut down as much as possible. The main bearings should be kept well oiled and in good condition. If one is cut, it should be replaced. The crankpin bearing should not fit too snugly, but should have enough clearance to show a movement when a pinch bar is put under it and jumped.

Pounding is often noticed in engines after a few months' operation. These are of two kinds—one is bearing pounds and the other is combustion knocks. If the engine is too hot, it will preignite and knock at each stroke. If the cylinder is too cold, the engine will knock a time or two and then seem to lose power, will drop in speed and then start knocking and speeding up.

Steam Jet Air Pumps at Union Street Railway Plant

IN CONNECTION with the description of the Union Street Railway Plant at New Bedford which appeared in the Aug. 15 issue of Power Plant Engineering, our attention has been directed to a misleading description of the Wheeler Steam Jet Air Pumps installed at that plant. The pumps described in the article are an obsolete type which the Wheeler Condenser Engineering Co. stopped building some time ago.

The pumps actually installed are of the latest design, size "C" pumps, and possess a number of improvements over the older type. These pumps have multi-nozzle jets instead of the single nozzle, and have a combined inter and after-condenser instead of the inter-condenser only. It is highly efficient and does away with any condensate tank, thermostatic control, etc., and the condenser, being of the surface type, keeps the air separate from the feed water. The multi-nozzle jets are capable of handling the same amount of air as the old single nozzle design on less than one-half the steam formerly required.

In Fig. 1 is shown a photographic view of the new type pump and in Fig. 2 it is shown in cross section. As may be noted, the design is similar to the surface intercondenser type with the addition of a compartment for condensing the steam from the secondary ejector. As this "after condenser" is of the surface type, the heat from the secondary steam is absorbed by the water flowing through the tubes while the air escapes through the exhaust opening as shown in the photograph. The passages within the water bonnets are so arranged that

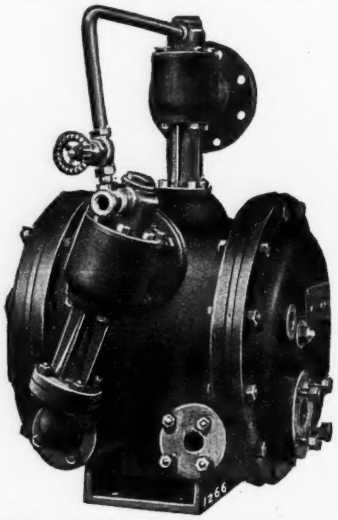


FIG. 1. WHEELER STEAM JET AIR PUMPS WITH COMBINED INTER-AND AFTER-CONDENSER

the water flows first through the inter-condenser and then through the after-condenser. With a surface condenser installation, this cooling medium is usually condensate from the main unit, so that complete recovery

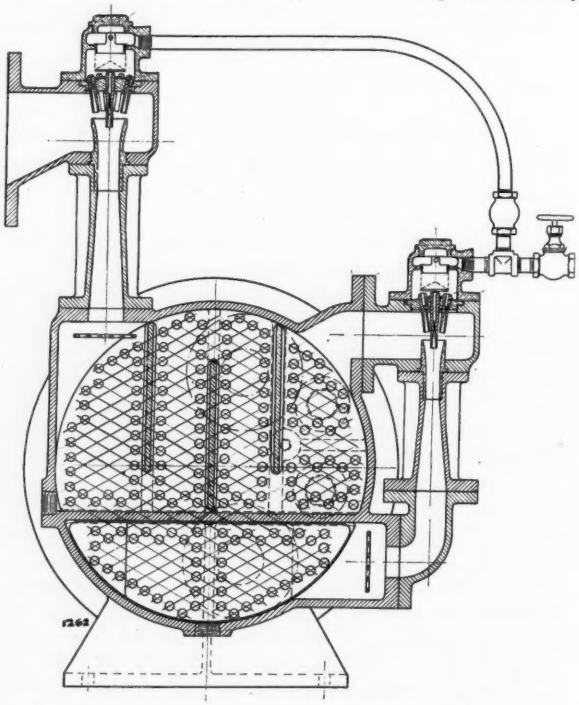
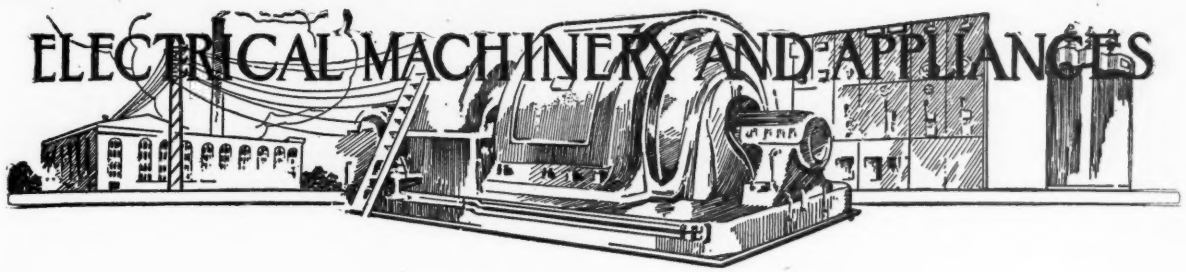


FIG. 2. CROSS-SECTION OF THE WHEELER STEAM JET AIR PUMP SHOWING MULTI-NOZZLE JETS

of all the heat in the motive steam is effected within the machine itself, and air free condensate delivered either to the main feed water heater or the boilers as the case may be.



Electric Motor Control

DISCUSSING THE VARIOUS METHODS OF STARTING AND SPEED CONTROL OF ALTERNATING AND DIRECT CURRENT ELECTRIC MOTORS

ALL TYPES of electric motors except those of very small capacity require some form of starting apparatus to limit the initial rush of current which tends to pass through the winding, when the armature, or the rotor in the case of alternating current motors, is at rest.

As is well known, the current through the armature of a direct current motor is limited almost entirely by the counter electromotive force due to rotation, and not by the ohmic resistance of the winding. When the armature is at rest, the counter-electromotive force is zero and as the ohmic resistance of the armature is low,

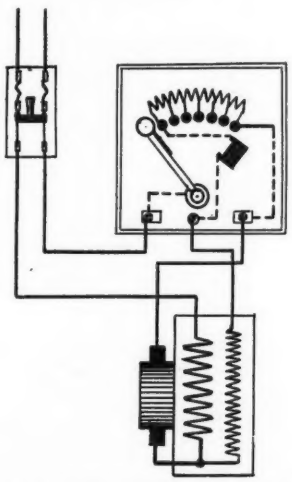


FIG. 1. TYPE OF STARTING BOX FOR USE WITH EITHER SHUNT OR COMPOUND MOTORS

it is obvious that if full voltage is impressed upon the terminals of the machine when at rest, extremely heavy currents will flow. As the machine speeds up, the counter-electromotive force increases in value, and finally when up to speed, it differs from the impressed voltage by only a few volts. When this condition is reached, the net voltage tending to send current through the armature is therefore the impressed voltage minus the counter-electromotive force.

In alternating current motors, although the principle differs, a similar condition exists. The electromotive force induced in the rotor of an induction motor is dependent upon the slip. If there were no slips, that is, when the speed of the rotor exactly equaled the speed of the rotating magnetic field, there would be no lines of force cutting the rotor conductors, and as a consequence no electromotive force would be generated, and no current would flow. When the rotor is at rest, a condition of 100 per cent slip is obtained and the electromotive force induced in the winding is at a maximum, and extremely heavy currents tend to flow. As the machine speeds up, the percentage of slip decreases and the current in the rotor also decreases.

It is evident from the foregoing, that unless some form of current limiting device is inserted into the armature or rotor circuit of an electric motor when bringing it up to speed, there is great danger of burning out the windings.

For direct-current motors, these starting devices usually take the form of a rheostat, the resistance of which is gradually cut out as the motor speeds up. In alternating current motors, starting may be accomplished either by inserting resistance into the rotor circuit, by means of a transformer with low voltage

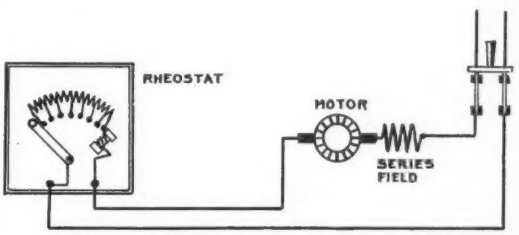


FIG. 2. SIMPLE FORM OF STARTING BOX FOR STARTING SERIES MOTOR

taps, with a starting compensator or auto-transformer, or by changing the connections to the armature coils by means of a switch.

STARTING BOXES

WHILE IT IS not within the scope of this article to describe the many different forms of starting rheostats in common use, the fundamental principles on which they operate are simply explained. A typical starting box, applicable to both current and compound motors, is illustrated in Fig. 1. As the lever is gradually moved across the contacts towards the right, resistance in the armature circuit is cut out and the motor speeds up. A no-voltage release coil is connected directly across the line and in series with the shunt field winding, the instant the contact arm is brought to the first contact. As resistance in the armature circuit is cut out, it will be seen that the resistance of the shunt field circuit is

slightly increased, a condition which assists in accelerating the armature. The object of the no-voltage release coil, is to provide an automatic arrangement for opening up the motor circuit and bringing the starting lever back to its original position in case the line voltage fails. For it is obvious that were no such arrangement provided, and the line voltage suddenly came on again, full voltage would be impressed across the motor terminals which, having stopped, due to failure of the line voltage, would draw excess current and probably burn out. With the no-voltage release coil, when the voltage fails, the magnetic force holding the starting lever in place will fail, and the lever, under the action of a spring, will return to its starting position.

In starting a series wound motor, the rheostat or starting box is placed in series with the motor as shown in Fig. 2. Since in this type of motor the field coils are in series with the armature, the ohmic resistance of the

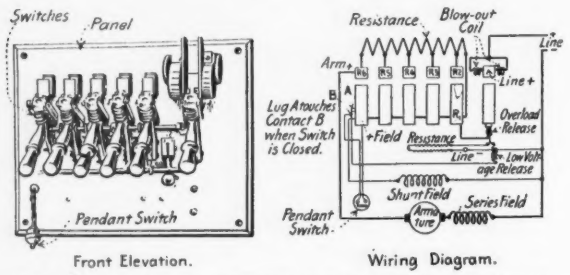


FIG. 3. MULTIPLE SWITCH FOR STARTING RHEOSTAT FOR USE IN CONNECTION WITH LARGE MOTORS

motor circuit is greater than in the case of the shunt wound motor, consequently less resistance is required in the starter.

In cutting out the starting resistance of any motor, care must be taken to avoid cutting it out too rapidly. If the starting resistance is cut out more rapidly than can be compensated for by the normal acceleration of the motor, the entire purpose of the starter will be lost and the motor may be damaged. On the other hand, care must also be taken not to allow the starting lever to remain on any intermediate contact for any length of time, as the resistance wire of which the starter is composed is not made to carry the motor current continuously and will burn out.

In order to eliminate the possibility of cutting out the starting resistance too rapidly and also to reduce excessive sparking at the rheostat contacts, large motors employ multiple switch starting rheostat, such as shown in Fig. 3. In this type of starter, each resistance unit is short-circuited by a separate lever or switch. These switches are so interlocked that it is impossible to close any one of them without first closing the one preceding it. To operate this starter it is necessary to close the switches in succession, beginning at the left-hand switch. As each switch is closed, it is held in place by hand until the one immediately next to it is closed, which procedure is continued until the last one is reached. This last switch is held in place by an electromagnet which also serves as the no-voltage release coil. It is therefore impossible, with this type of starting rheostat, to cut out resistance faster than it is possible to go through the successive motions of closing the switches. At the same time, the interlocking arrangement prevents allowing the motor to run with resistance in the circuit.

It is usual practice when installing starting boxes to place a line switch in series with them. In stopping a motor, this line switch is opened, thus cutting off the current through the no-voltage release coil and allowing the starting lever to return to the "off" position. It is essential that the motor always be stopped in this manner, and not by the process of pulling the starting lever back to the off position, for this will result in serious sparking and burning of contacts.

Starting Induction Motors

Small induction motors—those of less than 8 or 10 hp. capacity—may be started without a starting device by connecting directly across the line. This method is not to be recommended for motors larger than this, as it subjects the motor to severe strains and causes disturbance of the system from which it is fed. In starting motors in this manner, it is advisable that a double set of fuses be provided as shown in Fig. 4, one set for running and the other for starting. Since the starting current of an induction motor is usually four or five times the normal running current, it is obvious that if

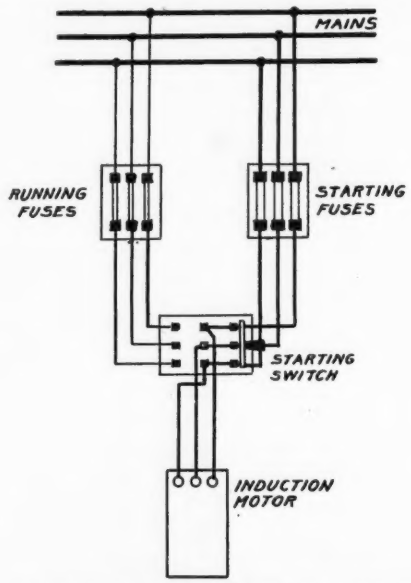


FIG. 4. DIAGRAM OF CONNECTIONS USED FOR THROWING SMALL MOTORS DIRECTLY ON THE LINE

fuses were provided large enough to pass the starting current they will not offer protection to the motor when running.

Resistance methods of starting induction motors are used only with motors of the wound rotor type. The starting resistance may be either internal or external. When an external resistance is used, the motor is provided with collecting rings and brushes, through which the external resistance is connected to the rotor winding. For small motors the starting resistance may be similar to the starting box of a direct current motor; on larger machines, the resistance is cut in or out by a drum controller in which case it is also used for speed control. A set of resistance units is connected with each of the three phases of the rotor circuit, all three being varied

simultaneously by a single controller handle as shown in Fig. 5.

The resistance method of starting induction motors is used largely on large motors where a means of speed control is also desired. The resistance grids, in this case, are usually made sufficiently heavy to carry the normal running current continuously. Coil wound rotor motors may be provided with a high and variable starting torque, by inserting a variable ohmic resistance directly in the rotor circuit, that is, within the machine itself. This resistance is cut in or out of the circuit by the operation of a switch on the motor shaft so arranged that the handle of the switch is stationary when the rotor is turning.

One disadvantage, characteristic of any method of resistance starting of motors, is that energy is lost in the resistance. From this point of view, the transformer or the auto-transformer methods of starting are to be preferred. Two winding transformers are little used for this purpose, however, and the auto-transformer or single winding transformer is usually employed.

Auto-transformers when used for this purpose are known as starting compensators, and consist of windings (one for each phase) wound on laminated iron cores, with taps brought out so that the voltage may be varied as desired. By means of a double throw switch the

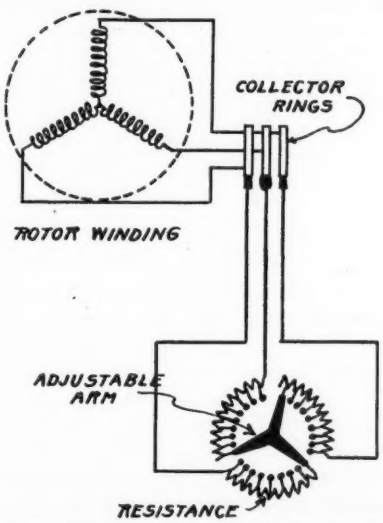


FIG. 5. EXTERNAL RESISTANCE METHOD OF CONTROL FOR WOUND ROTOR INDUCTION MOTORS

motor is first connected to the low voltage taps and, when up to speed, is thrown directly on the line. A typical starting circuit using this method is shown in Fig. 6. The compensator reduces the voltage across the motor at starting, at the same time allowing a heavy current to pass through the motor. All the energy supplied by the generator with the exception of a small loss in the compensator coils is used to start the motor. From this point of view it would seem that the auto-transformer is much superior to the resistance methods. Due to the low power factor obtained by the use of auto-transformers, however, this is not the case and the wattless component, to which the line drop is due, is about the same with either the compensator or the resistance method of starting.

The resistance method is considerably cheaper than the auto-transformer, which accounts for its extensive use in connection with small motors. The power taken from the line, however, is very much less with the compensator and it is therefore commonly used for starting large squirrel cage motors.

Another way in which 3-phase induction motors may be started is by the use of an arrangement which permits the stator windings to be connected either in star or in delta. This method, which is employed in starting motors of 25 hp. or less, is illustrated in Fig. 7.

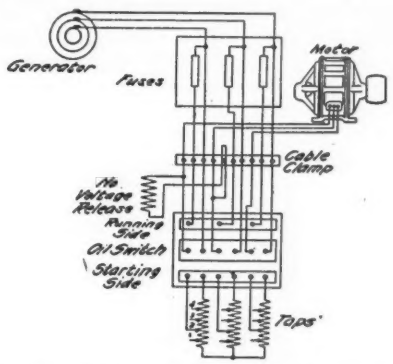


FIG. 6. CONNECTIONS FOR A THREE-PHASE STARTING COMPENSATOR

The six winding leads are brought out to a special form of star-delta switch, the initial position of which gives a star connection. The intermediate blade temporarily short-circuits the three upper terminals. The final or running position of the switch connects the stator windings in delta.

At starting, the voltage across each winding is equal to the line voltage divided by $\sqrt{3}$ or about 58 per cent of the line voltage. This, however, reduces the starting torque one-third its normal value, and for this reason the method can only be used where such a low starting torque is sufficient to move the load.

Speed Cotrol

The speed of direct current shunt wound motors may be controlled by either of the following methods: armature current control, field current control, variation of impressed voltage, reluctance of magnetic circuit control, multi-voltage control.

The first method listed is useful where the speed of the motor is to be decreased below normal and is accomplished by merely inserting a rheostat in series with the armature circuit. Due to the large current to be handled, a large rheostat is required and also because of its poor regulation, is not extensively used. The rheostat used in the second method, that is, for varying the field current, must have a high resistance owing to the small current which flows through the shunt field winding. The efficiency of this method is quite high and is applicable where a speed variation not in excess of 30 per cent above normal is required.

Variation of impressed voltage, although highly effective and efficient, calls for a more elaborate installation than can usually be afforded. A motor generator set is employed in this system. This motor generator set receives energy from the same source as the motor field coils. The generator supplies current to the arma-

ture. By varying the terminal voltage of the generator, it is obvious that any range of motor speed may be obtained. The system, however, is expensive, and except in highly elaborate installations, such as may be found on battleships, is not used to any great extent.

The fourth method, speed control by the variation of reluctance of the magnetic circuit, is accomplished by mechanically varying the relative position of the armature and the field poles. In one make of machine, this is accomplished by making the field poles hollow and placing within each a snugly fitting cylindrical iron core. By means of a system of bevel gears mounted on the frame and operated by a hand wheel, these cores may be moved inward or outward, thus varying the air gap and, consequently, the magnetic reluctance.

Multivoltage control of speeds consists in providing two or more separate supply lines of different voltage. By connecting the motor successively across the different

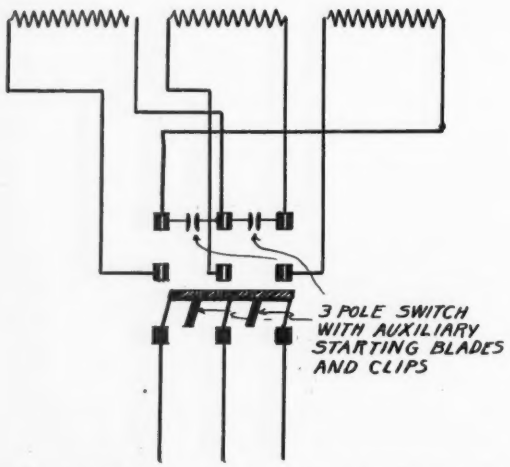


FIG. 7. DIAGRAM OF CONNECTIONS SHOWING SPECIAL STARTING SWITCH, USED IN THE STAR-DELTA METHOD

pairs of mains a limited range of speeds may be obtained, which may further be varied by means of the field rheostat. The limitations of this system, of course, are obvious.

Series Motor Speed Control

The speed of series motors is controlled either by shunting the series field coils or the armature with a rheostat or by placing the rheostat in series with the motor. If the resistance is placed in parallel with the series fields, the field strength will be diminished and the speed will increase. If the resistance is placed in parallel with the armature, the armature current will decrease and the speed also will decrease. This is known as the shunted armature connection and is useful where a low speed is required at light loads, or in cases where there is a possibility of the load becoming negative, that is where the load tends to drive the motor.

By placing the rheostat in series with the motor, the motor will draw the same current for a given load regardless of speed. This method of control is used largely in railway work.

The compound wound motor being a combination of a series and shunt wound motor, it is obvious that its speed may be controlled by any of the methods described for shunt and series motors or by combination of these methods. The speed may be reduced below normal by means of a rheostat in the armature circuit, it may be increased by shunting or even short-circuiting the series field or by means of a field rheostat in series with the shunt winding.

Speed Control of Induction Motors

Although the induction motor is practically a constant speed machine, its speed may be varied by a number of methods, each of which possesses certain advantages and disadvantages. These methods are as follows: variation of frequency of supply voltage, variation of rotor resistance, variation of number of poles, variation of applied potential, cascade connection, i. e., operating two or more motors connected in series.

As the speed of an induction motor is directly proportioned to the frequency it is obvious that this in varying the frequency of the applied voltage would have a means of speed control. Unfortunately, however, there are few instances where a variable frequency supply is obtainable and as a consequence the use of this method is extremely rare.

Speed control by varying the resistance of the rotor is a very satisfactory method, and although the speed is not constant over the torque range, it is useful where consistent speeds are most essential, such as in the operation of elevators, hoists, etc. As stated in connection

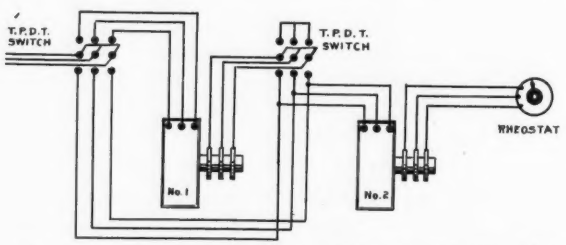


FIG. 8. TWO THREE-PHASE MOTORS ARRANGED FOR CASCADE OR INDEPENDENT OPERATION

with "starting," it is necessary that an induction motor controlled by this method be provided with a wound rotor. The Y connection is generally employed and an adjustable resistance is placed in series with each phase.

The third method listed, i. e., variation of number of poles, is coming into favor in certain applications of the induction motor, such as for the electric propulsion of ships. While the number of possible speeds is limited to the number of combinations of poles, it has proved a satisfactory method and is much used in marine work.

Speed control by a variation of applied potential has already been touched upon under "starting" and the connections are substantially the same as those of the compensator starting device, except that the contactors slide over the taps instead of being fixed in position. This method is not in general use, however, and the speed regulation obtained by it is very poor, while the efficiency and power factor decrease rapidly with the speed.

The use of the cascade connections of induction motors necessitates the use of at least two motors, the rotors of which are mechanically connected. The first motor has its rotor provided with a polar winding. This rotor circuit is connected to the stator winding of

the next motor, the rotor of which may be either of the squirrel cage or the slip-ring type. The circuit shown in Fig. 8 allows the two motors to be run either independently or in cascade. If the two motors tend to rotate in the same direction, the speed of the combination will be equal to the speed of a motor having as many poles as the two motors together. If, however, the two machines are so coupled that they tend to rotate in opposite directions, the speed of the set will be that of a motor having a number of poles equal to the difference of the numbers of poles of the two machines. These two methods of cascade connections are known as direct or differential cascade connections, respectively, and the conditions set forth above hold true only where the second motor is operated with a short-circuited secondary.

If two motors with different numbers of poles are used and an arrangement provided whereby the two machines may be connected in either direct or differential cascade, and by using each motor separately, four different speeds can be obtained. By providing the second motor with a variable rotor, resistance speeds between each of the four cascaded speeds can be obtained.

Owing to the poor operating characteristics and the expense of the equipment required, this method of control is rarely used. It produces a low power factor, and is low in efficiency.

The Phase Advancer

MACHINE SUPPLIES MAGNETIZING CURRENT FOR WOUND ROTOR MOTORS, THUS IMPROVING THE POWER FACTOR OF THE SYSTEM. BY F. S. WHEELER

THE QUESTION of operating power-factor and the means of improving the power factor in industrial plants is becoming more important each year. For this reason, all the various methods of correcting power factor have been studied with the idea of improving the operating conditions of such plants with the least expense and change in existing equipment.

There is no one solution which will apply to all cases because of the great variety of conditions to be met with in various manufacturing plants. One method which has been investigated and which would seem to offer advantages in certain applications where a number of comparatively large wound rotor induction motors are used, is by means of a phase advancer.

FUNCTION OF THE PHASE ADVANCER

THE POWER-FACTOR at which an induction motor operates depends upon the magnetizing current which it takes from the line. The less the magnetizing current the higher the power-factor of the motor. By supplying the magnetizing current from a separate generator, the power-factor may be raised to any desired value or may be made leading. The function of the phase advancer is to supply the magnetizing current for wound-rotor motors. The advancer is a small low-voltage, three-phase commutator-type exciter, designed to carry the secondary current of the motor with which it is used.

The secondary current passes through the armature and sets up a rotating field, which travels at a speed corresponding to the slip of the motor. By driving the armature in this field at the proper speed, sufficient voltage is generated to circulate wattless current through the motor secondary winding. This current, being at right angles to the line current, takes the place of the magnetizing current which is normally supplied from the line.

By adjusting the speed of the advancer, it is apparent that the operating power-factor of the motor can be adjusted to any value up to 100 per cent or can even be made leading. It is not desirable, however, to make the power-factor leading on account of the abnormal distribution of the currents in the motor windings.

The speed and efficiency of the motor are not affected materially by the advancer on account of the low resistance of its armature winding. The application of the phase advancer is therefore a convenient means of obtaining good power-factor with wound-rotor motors without a sacrifice in operating characteristics.

PERFORMANCE

CHARACTERISTIC CURVES are shown in Fig. 2 for a 150 hp., 440 v., 10-pole, two phase motor, having a full load efficiency of approximately 93 per cent and a power-factor of 81 per cent, with a full-load primary current at 166 amp. per phase. With the advancer the efficiency of the motor was reduced to about 91.5 per cent, but the power-factor was raised to 100 per cent and the line current was reduced to 136 amp. per phase. The load of the motor was thus reduced from 148 to 120 kv.a., or about 28 kv.a. capacity was made available for other purposes by the addition of the advancer.

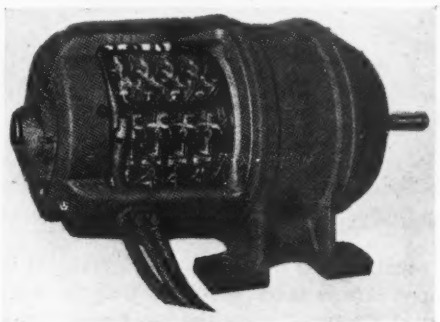


FIG. 1. EXPERIMENTAL 250-AMP. PHASE ADVANCER

RATING

THE RATING of the advancer shown in Fig. 1, is 250 amp., 600 to 1800 r.p.m. The current rating is determined by the secondary motor current, and the speed by the voltage required to drive the magnetizing current through the rotor winding.

CONSTRUCTION

THE MECHANICAL construction of the phase advancer frame is similar to that of a wound-rotor motor, although a special bracket is required on account of the large armature which is used Since no stator winding is required, a smooth iron core is assembled in the frame.

The rotor has the appearance of a direct-current armature, except that the commutator is longer. The size of the commutator is accounted for by the fact that it must carry the motor secondary current and magnetizing current. The assembled machine has every appearance of a low-voltage, direct-current generator. The front bracket is built with an open construction, so as to make the brushes accessible for inspection or repair. Covers are provided over the commutator for protection from dust or mechanical injury.

Drive

The advancer should be operated at a constant speed, and may be belted from the wound-rotor motor with which it is used. If desired, it may be operated

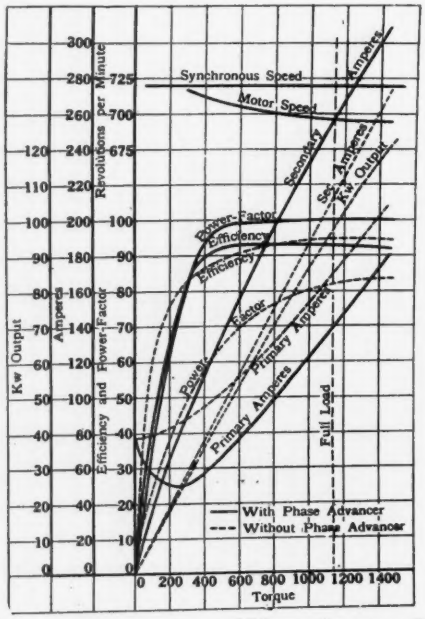


FIG. 2. CHARACTERISTICS OF A 150-HP. 2-PHASE, 10-POLE, 440-V. MOTOR, WITH AND WITHOUT PHASE ADVANCER

from a separate line shaft or by an individual motor, if the proper care is taken to insure that the advancer is running at all times when the main motor is in operation.

Power Required

Only a small amount of power is required to drive the advancer, as the current is generated at low voltage and low frequency. About one per cent of the motor rating is required to correct the power-factor to 100 per cent. This value will vary somewhat with the horsepower and speed of the rotor with which it is used.

Control

To start the motor the usual starting resistors and controller are required with provision to connect the advancer after the motor has come to approximately full speed. Should this connection be made at the time of starting, the advancer would probably be damaged by the high voltage of the secondary winding. No additional control equipment is required, however, because the proper sequence of contacts can be obtained with either drum controllers or remote control panels. A schematic diagram, showing the connections for a wound-secondary motor with starting resistor and phase advancer is given in Fig. 3. The two additional contacts X and Y in the star connection of the secondary circuit are provided in the controller. These contacts are closed for all positions of the controller, except the last or full speed point. Thus, during the starting period the secondary current passes through the starting resistors in the usual manner, but when the last point is reached contacts X and Y open simultaneously and the current passes through the three-phase armature winding of the phase advancer.

Operation

So far as the operator is concerned, the starting and the operation of the motor are the same as when no advancer is used. However, the operator should make sure that the motor has come to approximately full speed before throwing the controller to the last point. As explained before, this is to prevent possible damage to the advancer.

Reliability

The addition of an advancer to the motor equipment does not in any way increase the liability of a shut down or of loss of time in the factory, as will be seen from the following points:

1. It is foolproof in its operation, assuming that the

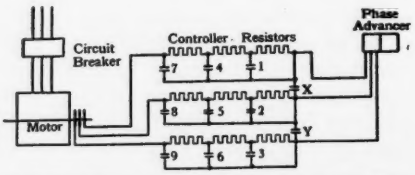


FIG. 3. CONNECTIONS FOR A WOUND-RECORDING MOTOR WITH STARTING RESISTOR AND PHASE ADVANCER

advancer is belted from the motor or a shaft which is always running when the motor is in operation.

2. It operates at a very low voltage, usually five to ten volts between phases.

3. It is simple in construction.

4. In case of trouble the phase advancer may be short-circuited and removed for repair without interrupting the operation of the plant for more than a few minutes.

Application

While the phase advancer has not been developed in this country for general application, a small machine rated at 30 amp. has been built for laboratory work. The operating characteristics of this unit in connection with an induction motor make a very interesting problem for laboratory and class room work for colleges and technical schools. This advancer is flexible in its application, as it may be used with any wound rotor motor up to 20 hp. capacity having a secondary current from 15 to 30 amp.—The Electric Journal.

Electric Power is now utilized in up-to-date Southern cotton fields for picking cotton. One operator can, with this picker, cover eight rows without changing his location. By hand only 70 to 150 lb. can be picked, while the machine picks some 400 to 700 lb. daily. The electric picker plucks the boll, and with a comb-like movement separates cotton from the boll. A blower device then cleans the cotton, placing the fiber in a receptacle nearby.

New Boiler Plant for Paper Mill

MODERN EQUIPMENT IN PLANT OF BOGOTA PAPER AND BOARD CO. SHOWS REMARKABLE SAVINGS BY ANDREW MCGREGOR.

SAVING in fuel, labor and other operating costs is the result of a recently completed boiler installation at the Bogota Paper and Board company's plant, Bogota, New Jersey. Their engineer, M. L. Bullard, supervised the drawing of plans and specifications, the erection of the building, and the installation of the equipment. The installation consists of three 518-hp. H-type Heine boilers, equipped with Foster superheaters and fired by Coxe stokers. The boilers replace four 200-b.hp. and two 300-b.hp. hand-fired boilers.

The boilers provide for a load of 1400 b.hp. Usually only two of the boilers are operated, leaving one in reserve. With the old installation all six boilers were required to provide sufficient steam to meet the same load conditions. Each boiler has 5180 sq. ft. of heating surface and is designed to operate at 208 lb. per sq. in. steam pressure with a superheat of 75 deg. F.

Coxe stokers permit the burning of a cheaper grade of coal. With the hand-fired boilers, No. 1 or No. 2 buckwheat coal was burned. Now No. 3 or No. 4 is used. There is also a favorable difference in coal consumption. Forty-three per cent more coal was burned in the old hand-fired plant than is used in the present new plant. This represents a considerable saving in the coal bills. The turn-over in personnel, and the number of men required on the boiler room force have been considerably reduced. Now only three men are required during the day and two at night. Heretofore, nine men were employed.

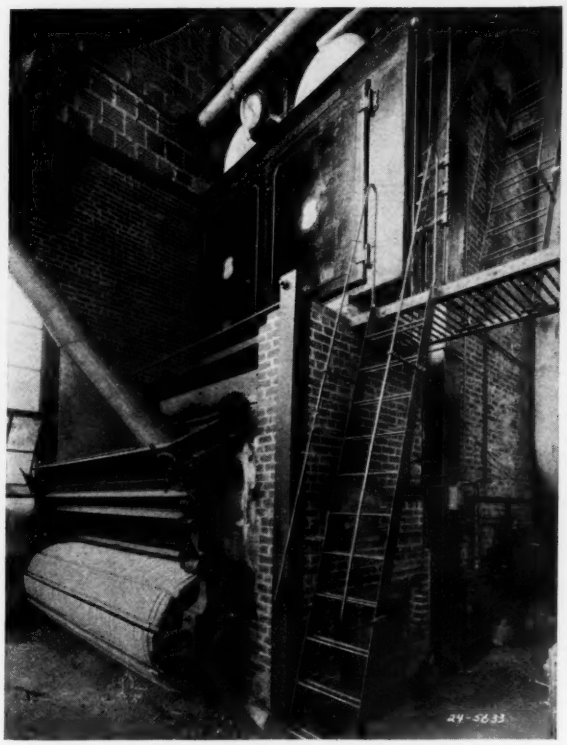


FIG. 1. ONE OF THREE BOILERS IN THE BOGOTA PAPER & BOARD CO.'S PLANT

Feed water is obtained from a nearby brook. It is preheated before entering the boiler, but is not chemically treated. The water passes through a Cochrane open-type and a Riley closed-type feed water heater, which raises its temperature to 240 deg. F.

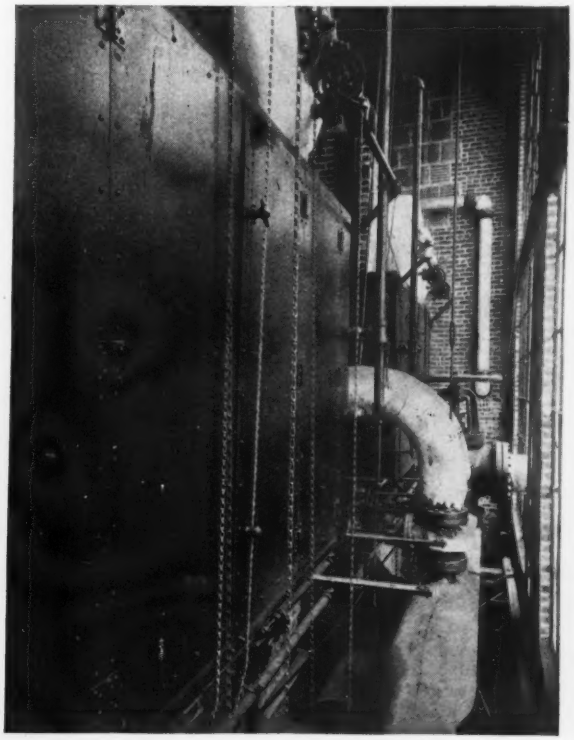


FIG. 2. REAR VIEW OF BOILERS SHOWING BLOWOFF PIPING FROM MUD DRUM AND WATER LEGS, SOOT BLOWERS AND MAIN STEAM HEADERS

Forced draft is provided by two Sturtevant Turbo fans, driven by Westinghouse 30-hp. shunt-wound direct-current motors with Cutler-Hammer controllers. The air ducts are cross-connected and so arranged that either of the fans may be used for any one or more boilers.

A Link Belt pivoted-bucket conveyor system provides means for handling the coal and ashes. The coal is dumped from the coal cars through a grating between the track rails onto a branch conveyor and is then delivered by the main conveyor to coal hoppers above the boiler room. Gravity chutes deliver the coal to the feed hoppers of the Coxe stokers. A Richardson automatic scale weighs the coal before it is burned.

Ashes are drawn out by hand from the ash chamber and dropped through gratings in the floor onto the same conveyor that handles the coal. They are delivered to an ash hopper adjoining the coal hoppers. A chute passes from the ash hopper to the outside of the building and enables the loading of the ashes onto trucks or cars.

Provision has been made for future expansion of the boiler room. The coal hopper for an additional boiler is already in place and at present a temporary wall is erected along the side of the end boiler. It will simply be necessary to install the additional boiler, remove the temporary wall, and thus enlarge the boiler room.

The plant is provided throughout with various instruments and devices so that it may be operated at maximum efficiency. It was put in operation April 1, 1922. Heretofore with the old boilers considerable trouble was experienced with the formation of scale on the boiler tubes, but the design of the new boilers, which includes a mud drum within the steam drum, has practically eliminated this trouble. It is now no longer necessary to turbine the boilers frequently, as was the practice in the past. The installation facilitates ready inspection and the plant is thus kept operating at maximum efficiency and minimum cost.

A Unique Reducing Valve

SPECIALLY DESIGNED ARRANGEMENT FOR REDUCING STEAM PRESSURE GIVES EXCELLENT RESULTS IN LARGE SUGAR REFINERY PLANT. BY C. C. BROWN

IN THE PLANT of a large Western sugar refinery corporation, where steam is used at several different pressures for the boiling of liquors and syrups, it became necessary to provide some means of passing, automatically, enough live steam from the 150-lb. main header to the 10-lb. exhaust header, so that the demand for the 10-lb. exhaust steam could be supplied and the 10-lb. pressure still maintained.

In order to furnish this live steam to the exhaust header, several makes of reducing valve were tried out. None was found, however, that would function properly in the reduction of steam over the extreme range of 150 lb. to 10 lb. The idea was to set the valve so that it would open up at 9 lb., and allow enough live 150-lb. steam to pass into the exhaust header to bring the exhaust pressure up to 10 lb. and maintain it there. At 10 lb. it was to shut off. As stated above, however, no valve was found that would stand up under this extreme service and it then became necessary to design a mechanism that would accomplish it.

For this purpose, a chronometer valve was designed to be made of bronze. This is a balanced valve with self-grinding ports. It is placed in a 6-in. line between the 150-lb. header and the 10-lb. exhaust header, the latter being protected by a Cochrane Multiport exhaust atmospheric relief valve of sufficient capacity entirely to relieve the 10-lb. header.

This balanced chronometer valve is operated by a lever and crank system as shown in Fig. 1, and hooked up in such a way that if anything happens to the regulator or hydraulic cylinder, the valve falls shut. The actual opening and closing of the valve is performed by a hydraulic cylinder. The hydraulic cylinder, in turn, is controlled by a Spencer type regulator. This regulator consists of an 18-in. rubber diaphragm through which the exhaust steam pressure acts against a lever and counterweights to operate a monel metal pilot valve. The monel metal pilot valve admits or relieves pressure to or from the hydraulic operating cylinder. The action of the regulator is as follows:

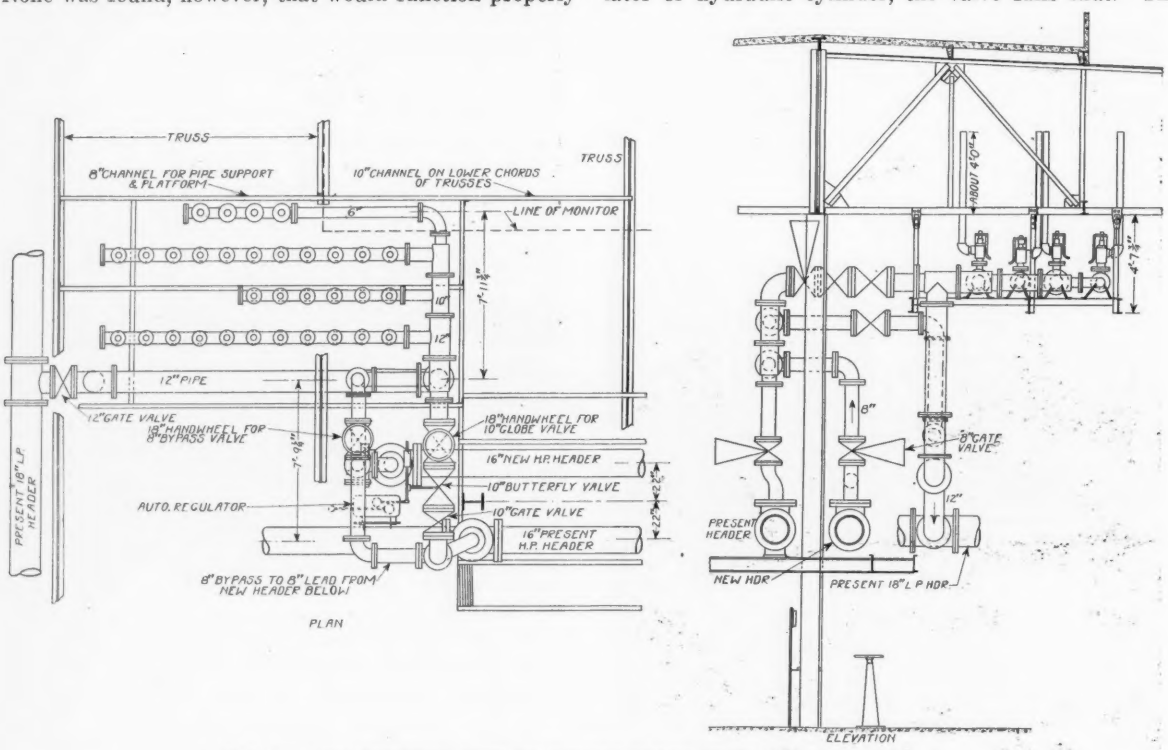


FIG. 1. ARRANGEMENT USED TO REDUCE STEAM FROM 150 LB. TO 10 LB.

When the pressure in the exhaust system falls to 9 lb., the counterweights overbalance the thrust of the 18-in. rubber diaphragm upon which the exhaust pressure is working and actuate the pilot valve to allow water pressure to enter on that side of the piston or that end of the hydraulic cylinder that actuates to open the chronometer valve and allow live steam to travel into the exhaust through the chronometer valve. When

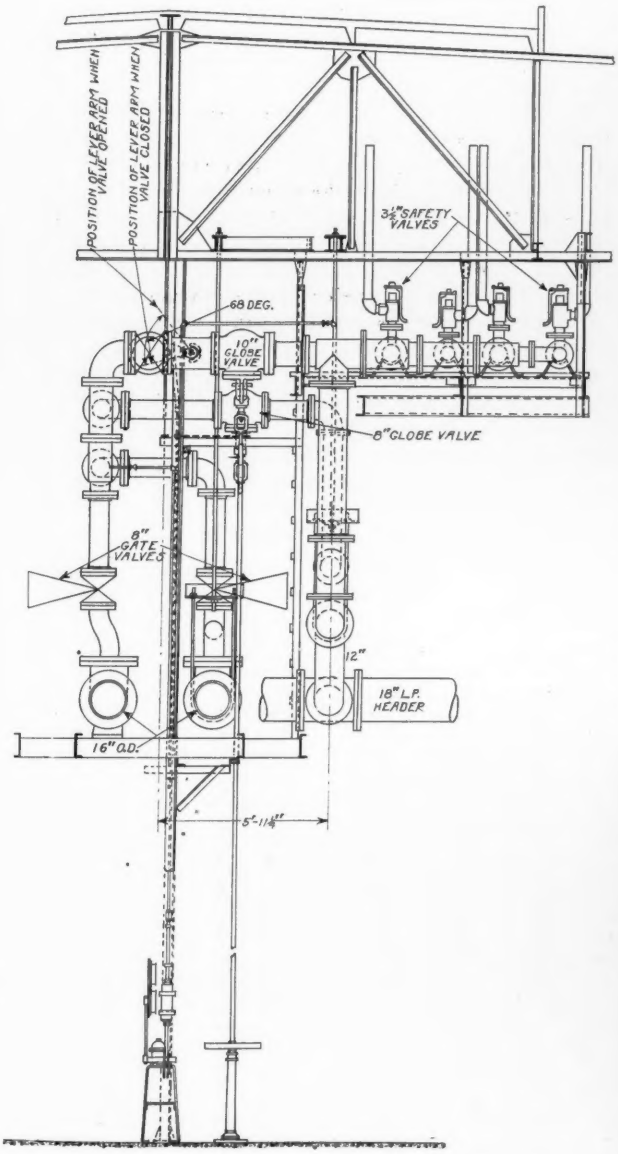


FIG. 2. REGULATOR FOR REDUCING STEAM PRESSURE FROM 150 TO 100 LB.

the pressure in the exhaust main has reached 10 lb., the pressure on the diaphragm exceeds that of the counterweights and the regulator operates to close the valve until the steam again falls to 9 lb. The quantity of "make-up exhaust" or the quantity of live steam that passes to the exhaust is measured by a G. E. flow-meter, so that a record is kept of the amount supplied.

The action of this reducing valve regulator has been very satisfactory since its installation about a year ago. It floats in the live steam and is very senstive and accurate, maintaining the 10-lb. pressure constantly.

At this same plant there is another similar service where steam is passed from the 150-lb. main to the 100-lb. header. This is, however, a smaller drop and consequently not so difficult.

The installation for this service consists of a Spencer regulator, a small hydraulic cylinder which actuates

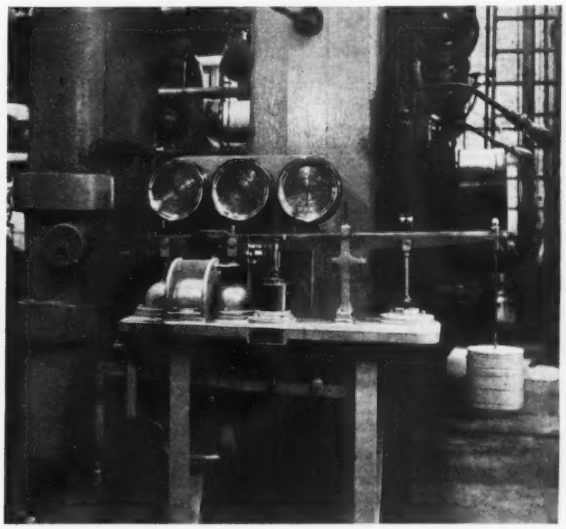


FIG. 3. SPENCER REGULATOR FOR USE IN CONNECTION WITH 10-LB. STEAM MAIN

a butterfly valve, thus allowing steam to pass from the 150-lb. header to the 100-lb. header through an 8-in. line, which contains a 3-in. diameter orifice. Figure 2 shows the arrangement of the several parts of the regulator.

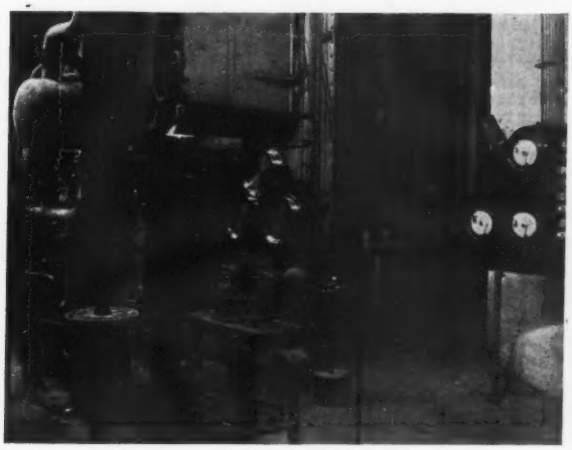


FIG. 4. SPENCER REGULATOR FOR HIGH PRESSURE SYSTEM

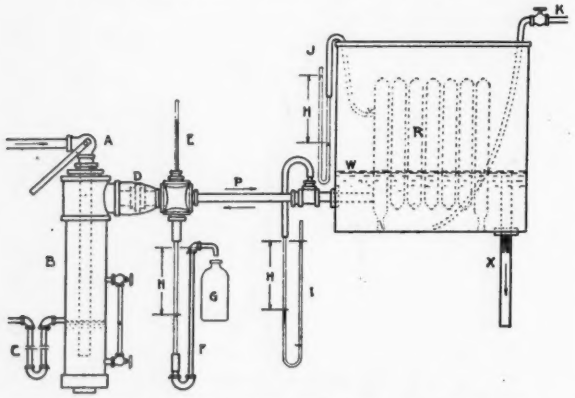
It will be noted that this cross-over valve from the 150-lb. header to the 100-lb. header is amply provided with safety valve capacity.

The use of this type, which is an unique and unusual design, has thus far proven very satisfactory indeed, the action of the regulators being automatic with few wearing parts. The only change made in the regulators since their installation was the substitution of monel metal for bronze in the pilot valves and chambers.

Critical Steam Velocity in One-Pipe Heating Systems*

VELOCITIES OF 20-30 FT. PER SEC. FOUND TO BE CRITICAL VALUES. BY F. E. GIESEKE†

WHEN STEAM, in a one-pipe heating system, flows with so low a velocity that the current of steam has no effect upon the flow of the condensate and the two opposing currents flow with uniform velocity, such a system functions properly. The maximum velocity which will permit of such functioning is the critical velocity.



APPARATUS FOR DETERMINING THE CRITICAL VELOCITY OF STEAM IN A ONE-PIPE HEATING SYSTEM

When the velocity of the steam exceeds the critical velocity a part or all of the condensate will be held back, temporarily or permanently, in the radiators or in the larger pipes by the current of steam, and the flow of the condensate will consequently be irregular or intermittent, or will cease entirely.

To determine the critical velocity of steam in various pipes and valves, the writer conducted two series of investigations.

In the first series, steam at a pressure of 4 in. of water only was used; in the second series steam at pressure of 4 in., 12 in., and 20 in., was employed.

The illustration shows the apparatus used during the latter part of the second series of tests; it consists essentially of a valve *A*, through which steam is supplied; a pipe *P*, for which the critical velocity of the steam is to be determined; and a condenser *R*, of variable capacity, by means of which the velocity of the steam in the pipe *P* could be regulated.

Steam was passed through a hand-operated modulating valve *A*, into a steam separator *B*; the separator consisted of a 5-in. pipe with an overflow *C* and a 1½-in. pipe through which the steam entered the separator in such a way as to pass through a body of water in order to remove any superheat which the steam might have. From the separator the steam passed through a well insulated connection *D*, to the pipe *P*, to be tested, and through this pipe to the radiator *R*, in which it was condensed. The condensate flowed through the pipe *P*, into the manometer tube *F*, and through that tube into a ves-

CRITICAL VELOCITIES IN PIPES, ORIFICES, VALVES, AND RADIATOR CONNECTIONS

Type	Diam.	Pitch, Inches per Foot	Pressure, Inches of Water Velocity 4	12	20	Average Velocity	B.t.u. per hour with 4 in. Pres.	Sq.ft. of Radiation at 250 B.t.u. per sq. ft.
Horizontal pipe, 12 inches long..	1	1/32	22.2	22.4	22.3	22.3	17,600	70
Horizontal pipe, 12 inches long..	1-1/4	1/32	22.5	22.8	22.6	22.6	30,900	123
Horizontal pipe, 12 inches long..	1-1/2	1/32	23.2	23.7	23.3	23.4	43,400	173
Horizontal pipe, 12 inches long..	1	1/8	24.8	24.5	24.6	24.6	19,400	77
Horizontal pipe, 12 inches long..	1-1/4	1/8	25.1	25.1	24.9	25.0	34,200	136
Horizontal pipe, 12 inches long..	1-1/2	1/8	27.4	27.0	27.2	27.2	50,500	202
Horizontal pipe, 12 inches long..	1	5/32	25.6	25.4	25.6	25.5	20,100	80
Horizontal pipe, 12 inches long..	1	1/4	27.0	26.8	26.8	26.9	21,200	84
Horizontal pipe, 12 inches long..	1-1/4	1/4	27.1	27.2	26.8	27.0	36,900	159
Horizontal pipe, 12 inches long..	1-1/2	1/4	29.2	29.4	29.1	29.2	54,100	216
Vertical pipe, 12 inches long....	1		30.5	30.4	30.8	30.6	24,200	96
Vertical pipe, 12 inches long....	1-1/4		32.3	31.8	31.7	31.9	43,600	174
Vertical pipe, 12 inches long....	1-1/2		34.2	35.9	35.6	35.2	65,400	261
Orifice in thin vertical sheet...	3/4		22.9	22.1	22.2	22.4	9,000	36
Orifice in thin vertical sheet...	1		22.5	22.2	21.9	22.2	15,900	63
Orifice in thin vertical sheet...	1-1/4		29.3	29.2	28.1	28.9	32,800	131
Orifice in thin vertical sheet...	1-1/2		25.0	24.7	25.5	25.1	40,400	161
Orifice in thin horizontal sheet.	3/4		23.2	22.8	22.6	22.9	9,200	36
Orifice in thin horizontal sheet.	1		23.4	22.7	22.9	23.0	16,500	66
Orifice in thin horizontal sheet.	1-1/4		27.4	26.8	26.8	26.7	30,200	120
Orifice in thin horizontal sheet.	1-1/2		22.7	22.8	22.7	22.7	36,600	146
Angle radiator valve.....	1		21.4	20.8	21.1	21.1	15,100	60
Angle radiator valve.....	1-1/4		22.1	21.8	22.4	22.1	25,000	100
Angle radiator valve.....	1-1/2		19.3	19.0	19.8	19.4	31,200	124
Corner Radiator Valve.....	1-1/4		20.0	19.8	19.4	19.7	22,400	89
Radiator connection angle valve..	1-1/4		18.3*	18.8*	18.9*	18.7*	25,600	102
			22.1**	22.6**	22.7**	22.5**		
Radiator connection corner valve.	1-1/4		16.7*	16.5*	16.4*	16.5*	22,600	90
			20.1**	19.8**	19.7**	19.9**		

*Based on diameter of pipe. Orifice sizes are actual sizes.

**Based on diameter of opening in valve. Pipe sizes are nominal size.

*Abstract of paper presented at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, Buffalo-Detroit, June, 1922.

†Head, Engineering Research Division, University of Texas.

sel *G*, of known capacity. By measuring the time necessary to fill the vessel *G*, the velocity of the steam in the pipe *P*, could be calculated.

The radiator *R*, was located within a galvanized iron tank and partly immersed in running water; the water was admitted to the tank through the pipe *K*, and the attached hose, and was discharged through the pipe *X*. The discharge pipe had a long and easy fitting thread so that the pipe could be turned by hand and the level of the water varied at pleasure.

In conducting a test, the first run was made with the water level, *W*, very low; additional runs were then made, each one with the water level slightly higher than during the preceding run. The time necessary to fill the vessel *G* was noted for each run and the shortest observed time corresponded to the highest velocity, i. e., to the critical velocity, since when the time necessary to fill the vessel increased, although the water level *W* was raised, some of the condensate was evidently held back by the current of steam.

In a 1-in. black pipe, 12 in. long and sloping 5/32 in. in 12 in. with steam at a pressure of 12 in. of water. The shortest time was 6:10 and corresponded to a velocitiy of 25.4 ft. per second.

The critical velocity of 25.4 ft. per sec. was calculated as follows: The vessel contained 991.7 cc. of water or at 212 deg. F. 2.1 lb. of water. The flow of steam through the pipe *P* was therefore 0.0057 lb. of steam per second or at a pressure of 12 in. of water, 0.148 cu. ft. per sec. The cross-sectional area of the pipe was, by measurement, 0.842 sq. in. and hence the velocity of the steam, 25.4 ft. per sec.

This value is not, however, the actual maximum velocity of the steam, but only a theoretical value from which the maximum quantity of steam flowing through the pipe can be calculated by assuming the entire pipe to be filled with steam. In reality only a part of the pipe is filled with steam and the remainder with water and the actual maximum velocity of the steam is therefore higher than the critical velocity calculated above. The difference between these velocities may be considerable. For example, in the case of the circular orifices in vertical brass plates it was quite evident from the stains on the brass plates that the current of condensate occupied a considerable portion of the cross-sectional area of the orfice and that therefore the maximum velocity of the steam through the concentrated opening in the orifice was considerably greater than the value calculated for the critical velocity and shown in the accompanying table.

By the method outlined above, the critical velocity of steam has been determined for short horizontal pipes, short vertical pipes, circular orifices in thin brass plates in vertical and horizontal positions, angle radiator valves, and the ordinary short radiator connections employing short vertical and horizontal pipes and either angle or corner valves.

The results of these determinations are shown in the accompanying table. The critical velocities in this table were calculated for the actual internal diameters of the pipes and for the actual openings in the valves.

An examination of this table shows that:

a. The critical velocity is practically independent of the steam pressure.

b. The critical velocity increases slightly with the diameter of the pipe.

c. The critical velocity is decidedly higher for vertical than for horizontal pipes.

d. The critical velocity in nominally horizontal pipes increases with the slope of the pipe.

e. There is no definite relation between the critical velocities in orifices and those in short pipes.

f. Considerably less steam can flow through an angle valve than through a short pipe of the same nominal size partly because the critical velocity is lower in the angle valve than in the pipe and partly because the opening in the valve is smaller than that in the pipe.

g. Less steam can flow through a corner valve than through an angle valve.

h. The capacity of the ordinary radiator connection is determined by the capacity of the radiator valve.

It should be noted that the number of B.t.u. shown is based on a steam pressure of 4 in. of water and that the number of B.t.u. transmitted increases slightly as the steam pressure increases; for example, if the pressure is increased from 4 in. to 5 lb. gage, the number of B.t.u. is increased about 25 per cent.

The table shows clearly that a considerable economy would be effected if the manufacturers of radiator valves increased the size of the openings in the valves so that as much steam can pass through them as through a short vertical pipe in a one-pipe system.

Automatic Substation Undergoes Severe Service Tests

IMMEDIATELY after its installation, a new automatic substation in the plant of the Northern States Power Co. of Minneapolis was subjected to a severe service test.

The sub-station, which was built by the Westinghouse Electric & Manufacturing Co., feeds the downtown system of Minneapolis and is equipped with a regulator which automatically keeps the voltage constant unless the load tends to exceed the machine capacity, in which case the voltage is lowered until the load is within the rating of the machine. If a very heavy load comes in, the voltage is kept reduced until the load lightens; the regulator then automatically brings the voltage to normal.

Immediately after the installation of this sub-station, a heavy sleet storm caused several short circuits which completely threw out the downtown district, except for a standby battery for emergency use which was too small to carry the peak load at full voltage.

Ordinarily it is very difficult to pick up load after an "outage" on such a system if the demand is very heavy, as it was in this case, because all the breakers can not be closed at once and any one machine or substation cannot carry the load at normal voltage. As soon as one breaker is closed, it comes out again. In this case, however, the automatic regulator at once cut down the voltage of the generator until the load drawn from this set was 6000 amp. (load and a half). The machine kept in service at this rate until the manual station could be started. The voltage regulator then automatically brought the generator voltage to normal as the load was shared with the other stations.

Professor Stumpf Outlines Field of Unaflow Engine

IN AN INTERVIEW with Professor J. Stumpf, inventor of the Unaflow engine, and C. C. Trump, vice-president of the Stumpf Una-flow Engine Co., Professor Stumpf indicated the future use of Unaflow engines in sizes below 100 hp. The small simple engines, both vertical and horizontal, now in common use for driving auxiliary equipment such as fans, pumps, small generators, etc., possess high water rates. The majority of these small machines are of the simple slide valve type. By replacing these machines with engines of the Unaflow type, a marked gain in economy would result. There is a great opportunity for engine manufacturers in this field, said Professor Stumpf.

In regard to extreme large sizes of Unaflow engines, Professor Stumpf said there was little danger of their creating serious competition with the large steam turbine. While it is a fact that Unaflow engines as large as 18,000 hp. capacity are at present under construction, they are being built for purposes where a high starting torque is required, such as for rolling mill work in the steel industry. The steam turbine is used in practically all cases to drive alternating-current generators; these, like the turbine, being high-speed machines, are ideally adapted for turbine drive; hence, there is little danger of the Unaflow engine, which is a low-speed machine, encroaching upon the steam turbine's field of usefulness.

There is, however, said Professor Stumpf, a field for the Unaflow engine in the driving of large direct-current generators such as are used in railway work. The direct-current generator, which is inherently a low-speed machine, is not very readily adapted to the use of the turbine drive because of the necessity for reduction gearing. For this reason, the direct-current generator can be driven more economically by direct connection to the Unaflow engine. In fact, in all cases where a comparatively low speed is required for the larger size units, the Unaflow engine can be used.

Another development which Professor Stumpf is working on, is in the effective utilization of the exhaust energy in reciprocating engines. The principle involved is similar to the principle of the Hydracone Regainer in hydraulics, and consists in the use of nozzle-shaped exhaust pipes and diffusers which enable the kinetic energy of the gases leaving the cylinder to be used effectively. The principle is applicable to both steam and internal combustion engines, and Professor Stumpf's experiments indicate a reduction in the size cylinder necessary for a given capacity by the successful application of this principle.

In submitting bids to prospective purchasers of Unaflow engines, Professor Stumpf indicated the need for a uniform method of rating the engines. At present there is considerable variation in the size of cylinders of Unaflow engines in the designs submitted by different competing manufacturers for an engine to be supplied for a certain purpose. In Germany, Professor Stumpf said, manufacturers furnish the buyer with a chart showing the consumption of steam at various points of cutoff and also the maximum overload which the engine is capable of carrying. This basis of rating is more or less standard among the different manufacturers, and the result is that there is little difference in the size of cylinders for an engine of a certain rated capacity. This makes for a lower cost of manufacture, and serves to establish a greater degree of confidence in the Unaflow engine on the part of the buyer. The buyer also can render his assistance, if, when ordering, he informs the manufacturer, not only the rated horsepower of the engine but also the point of best economy and the probable overload to which the engine may be subjected.

Mixtures of Fine Coal and Fuel Oil For Emergency Use

AS AN EMERGENCY fuel, a mixture of fuel oil with fine coal in as large proportions as the coal will absorb and hold is suggested by the United States Bureau of Mines to steam coal users and gas manufacturers to augment their fuel supply during the present shortage.

Slack coal that has a high percentage through an 8-mesh screen, or which may be crushed to sizes of one-eighth inch or less, will take up in oil from 30 to 40 per cent of its own weight and make a fuel high in calorific value. Coarse slack coal, however, as judged by a representative sample from the Pittsburgh market, will absorb oil to only 3 to 10 per cent of its own weight, which would give a fuel having only about 4 to 15 per cent increased heating value. The finer the size of the coal, therefore, the larger is the amount of oil which will be held. Tests made by the Bureau of Mines at its Pittsburgh experiment station indicate that the mixture can be made with either bituminous slack or anthracite culm.

This method bears a relationship to the Trent process of purfying coal by fine grinding and amalgamation with oil, now in operation at a plant at Alexandria, Va., which has demonstrated the success of a combination of oil and coal for steam-making, gas manufacturing and other fuel purposes. The present emergency proposal does not contemplate the cleaning process, but involves merely the simple mixing by shovel or concrete mixer. The Trent Corporation has volunteered to assist the Government in advising in the use or application of oil-mixtures, and to waive this emergency any claim or infringement of its process which may or may not be involved by the simple mixing of fuel oil and coal, without reference to cleaning.

An oil refinery at Baltimore, it is reported, mixed by shovel a ton of heavy Mexican fuel oil with two or three tons of western Maryland slack coal, and used it successfully in a switch engine. At the experiment station of the Bureau of Mines at Pittsburgh, it was found that mixtures containing one ton of Mexican fuel oil and four to five tons of Pittsburgh slack coal could be used in a hand-fired furnace.

In using oil-mixtures, the fire will smoke badly after firing, or while breaking up the coke bed from time to time. From such limited amount of testing as has been done by the Bureau of Mines, it was shown that careful firing is required to prevent continuous smoking. Experimenting must be done in each case to determine the best method of firing.

Chain grates and certain other automatic stokers are probably well adapted to handle the oil-fuel mixture if

the bin and feeding devices are suitable. Oil-mixtures will not fire spontaneously, but undoubtedly care should be exercised to ventilate bins where external heat may tend to drive off lighter gases, although the fuel oil which is on the market has had the lighter oils distilled from it.

Anthracite culm or dust which would sift through ordinary grate bars can be used successfully when mixed with the oil, as the oil causes it to adhere and the oil residue cokes as soon as heated. Oil and anthracite mixtures are not smokeless with hand firing, the Bureau of Mines tests indicate.

This simple mixture of fuel oil and coal is proposed by the Bureau of Mines merely as a temporary measure. While under conditions of normal fuel supply such a mixture probably would not prove satisfactory unless it involved the cleaning feature embraced in the Trent process, in places where fuel oil is available it can be used to piece out a poor coal supply without the changes in equipment necessary to convert boilers to oil burning.

Co-ordination to Advance Safety*

Co-operation Between Engineering and Operating Departments Is Essential. By J. H. Warnick.†

MANAGERS of gas or electric properties must be thoroughly sold on the safety movement for the engineer to get very far. In any organization, where the engineer is subordinate to the manager, he must convince the manager through proper argument of the necessity for spending money in connection with carrying out his various recommendations. The most telling argument, from a selfish standpoint, is the presentation of statistics showing a saving to the company as well as employes over a period of years. The hard-headed business men who cannot visualize the distress to the worker and his family due to an accident, even when the worker is paid under compensation laws, and who cannot visualize the economic loss to the company due to an accident, can be pulled across when the proper statistics are presented.

It is important to keep proper statistics and use them in publicity work to show everyone connected with the organization the progress being made. All other departments are operated on a basis of statistical comparisons.

I assume that the engineer is sold fundamentally, as that is his natural ground—to consider the safeguards in the planning and erection of any engineering project. In public utilities he is responsible for the safety of the people served as well as for that of the employes. The engineer's work should start in the designing room. Accident prevention is more readily controlled if due consideration is always given to the elimination of the personal element. Safeguards should be automatic, as far as possible, and of a permanent nature.

All large public utility properties should have in their employ a competent safety engineer. Preferably he should be a man trained by experience in the character of the work with which he is associated and he should have a good personality as this is a most important factor in obtaining co-operation from the working force. He should be diplomatic, a good mixer and one who is always welcome among the workmen. Frequent discussions should take place between the safety engineer and the chief engineer when planning new construction work, so that hazards may be prevented as far as possible. All completed drawings should be approved by the safety engineer, from his viewpoint, before erection work is started. The engineer, in designing plans for new construction work, should take heed of the past experience with reference to accidents and make efforts to eliminate the possibility of similar accidents in his designs. Sometimes a little thought given at this stage of the work will evolve a plan that is somewhat different than past experience has dictated. In many cases the plan would be more desirable if due consideration is given to the safe operation and the elimination of the possibility of accident hazards. This can be done by systematically educating the men in charge of designing work by frequent discussions with them and by the chief engineer himself being continually on the lookout for accident possibilities when approving any new construction plans. The co-operation of the construction engineer in carrying out the plans made in the designing room can generally be obtained by the chief engineer showing a personal interest in the work as it progresses and by taking up with him any hazards that may have escaped the attention of the designers. A thorough discussion of these conditions will interest him in the necessity of building for safety of operation. Slight changes can be made at small cost during the construction period that will greatly increase the safety of the plant.

The engineer in charge of the situation must make it perfectly plain to his subordinates and assistants that he is thoroughly behind the safety movement. He must place the responsibility on the shoulders of the heads of the various departments for the carrying out of the ideas and recommendations made by the safety engineer, after the chief engineer has passed upon same and decided that they should be carried out. This can only be done by having frequent inspections made by the safety engineer, followed by a formal report to the chief engineer, who in turn will follow the matter up and see that the recommendations are carried out as promptly as possible.

In the operation of any power or gas plant a great deal can be accomplished in the prevention of accidents by a systematic inspection of the property from time to time, covering all phases of the operation.

At one time I was superintendent of a gasworks where we developed a form of inspection that was very beneficial in not only improving the efficiency of operation but materially improving the appearance, housekeeping and physical condition of the property so that fire and accident hazards were reduced to a minimum. The form was so designed that the inspection covered certain parts of the plant daily, other parts weekly and some only monthly. In this way things that needed correction and were not properly in order were brought

*Abstract of a paper read at the Eleventh Annual Safety Congress of the National Safety Council.

†Engineer, Northern Indiana Gas & Electric Co., Fort Wayne, Ind.

to the direct attention of the superintendent. Orders were immediately issued to the foreman in charge of each department, insisting that conditions that needed correction, such as leaks in steam, oil or water piping, housekeeping, etc., be remedied as soon as possible. The foremen in the various departments would report back when conditions had been remedied and the inspector would check up the matter through his daily inspection until all of the defects were corrected.

It has been my experience that if the superintendent in charge of a plant insists on everything being orderly and the housekeeping kept up-to-the-minute that the moral effect on the men under him is such that he has a minimum of accidents. Employes simply cannot ignore the general conditions surrounding them if they are elevating and the defects show up immediately. On the other hand, laxity on the part of the executive in charge of the plant in the matter of general housekeeping and carefulness in following up of the maintenance of his property will give employes an excuse to become careless and negligent.

We also developed questionnaire forms covering the inspection of the vital parts of the plant when down for repairs, such as boilers, large units, generators and water-gas sets. The object of using these forms was to make sure that the mechanical parts of the unit were thoroughly inspected when down for repairs and the form was so designed that it would bring the matter to the attention of a high-grade mechanic responsible for making the inspection, who would determine what was necessary to put the unit in first-class mechanical condition before it would go into service again. Forms were developed by keeping in mind the fact that the unit should always go back on the line in the same condition as when new and the construction drawings were used in developing these forms.

Where maintenance work is not followed up, emergencies frequently arise and the plant does not run as smoothly as it should under normal conditions. Emergencies always give more chance for accidents than where everything is running along smoothly. The whole point is that we must train these men to look ahead as far as possible and anticipate trouble, thereby make the remedy necessary in time to avoid the possibility of an accident.

Keep the Employes Interested

The employe can only be kept interested through constant effort on the part of the management and the plant executives in educating them to the benefits of a reduction of accidents. The general practice is to form clubs, which are primarily constituted for educating employes along the lines of accident-prevention and first-aid work.

Where it is possible to fairly distribute prizes for competition between departments in the maintenance of good accident records it should be done. A very important thing is to have the shop and plant inspections made by a committee of the employes who will work in co-operation with the safety engineer. Sometimes they will make recommendations that may sound somewhat impractical to the management, but there is no question but that 90 per cent of them are well founded and should be carried out immediately, backed to the limit by the management.

It is very essential that the employes be trained to report accidents, no matter how trivial, immediately upon sustaining same. In this connection first-aid equipment must be stationed at the proper places throughout the plant and kept in first-class condition so as to be available for immediate use at all times. In gas and electric work it is essential that drills for gas asphyxiation and electric shock be made frequently. We have found the best method to excite the interest in this work and to thoroughly instruct all the employes in the methods in use is to form competitive drill teams and offer prizes for the ones who are the most efficient. These drills must be made periodically, as they are far too important to be allowed to slide.

The new employe who is continually having accidents which are simply due to the fact that he fails to think and who shows through several trials that he is never going to be able to do any thinking, is a liability. In my opinion it is best to get rid of such a man. He is not only a menace to himself but to everyone around him and the longer you carry him the greater the liability.

A very important point that is frequently overlooked is the question of training new employes for responsible positions. One must be very careful not to place a man in a position where he is handling a dangerous operation until he is thoroughly trained and broken into the job. He should be placed under the guidance of the most experienced men in the organization and frequently their judgment should be solicited as to when the man has demonstrated, in their opinion, that he is qualified to handle alone the position for which he is being trained.

Fire Protection

Periodical inspection should be made by representatives of bureaus and authorities who are thoroughly familiar with fire underwriter standards, so that construction improvements can be recommended that will reduce the hazards and also the insurance rates at the same time. Of course it is necessary that fire-fighting equipment be inspected periodically, preferably by the safety engineer, to insure that it is maintained in a state of 100 per cent efficiency at all times. Sometimes the safety engineer can recommend advantageous changes in the locations of the fire-fighting equipment, based on his study of past experience, as it frequently happens that fire extinguishers and water pails will be placed at points that will be difficult to reach in the event the building should take fire. It is absolutely essential that avenues and aisles leading to the equipment be kept open. It should be borne in mind that entrances to a building are generally the places where one can first start to attack a fire and for that reason these are the logical points at which to locate extinguishers. Every situation should have a fire brigade, thoroughly trained and drilled frequently. These drills will insure the fire hose being kept in first-class condition.

The latest obtainable figures covering the use of the incandescent lamp shows that Colorado has 114,200 homes using the incandescent lamp, an increase of 6500 homes over last year. Wyoming has 18,800 of her homes electrically lighted, an increase of 3100 over last year, and New Mexico with 14,900 homes emblazoned with this bright light increased her number 900 over last year.

Burning Sawdust

UNDER two 72 in. by 18 ft. tubular boilers carrying 140 lb. pressure white pine sawdust was burned on herringbone grate bars, and the boilers steamed easy with natural draft without adding wood. After 2 yr. the white pine gave out and hemlock took its place. It was then impossible to keep steam without a great deal of hard work and using 13 loads of dry rattlings at a cost of $1.25 a load. The hemlock logs floated down the Mississippi River some 300 mi., thus becoming so waterlogged they would hardly float at all, hence it was next to impossible to burn enough of this sawdust to keep up the pressure. "Step down" hollow blast grates were installed which were a great help, still five loads were used and much sawdust had to be

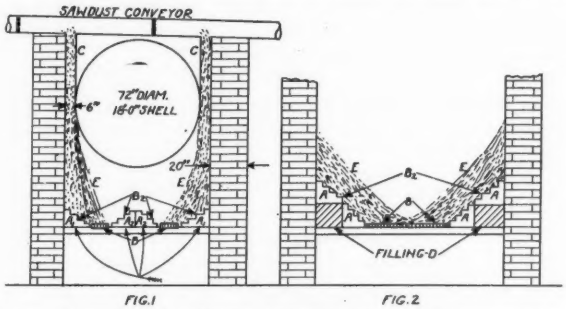


FIG. 1. ORIGINAL GRATE ARRANGEMENT FOR BURNING HEMLOCK SAWDUST

FIG. 2. REVISED SAWDUST GRATE

carted away at the expense of $4.00 a day. The new grates were set according to instructions from the makers. The sawdust was dropped down between the boiler and furnace walls through a 6 by 12-in. square hole over the boilers. Sawdust being carried past these holes with the usual scraping conveyors and the amount of fuel regulated in the usual way with slides and levers.

The grates were 84 in. long by 8 in. wide, four to each boiler and the regular sawdust grates used between these four blast grates as indicated in illustrations. It will be noticed in Fig. 1, grates A_2 with air holes B_2 through grates were always uncovered, the blast blowing the sawdust back as it came towards these two center grates A_2. To avoid as much of the excess cold air blowing through as possible, with much effort or labor the grates were kept covered with wood and some dust, which always broke down the fire more or less, sending it up the stack, for with such fuel a good strong draft is required. After 2 yr. of using the grates as shown in Fig. 1, the grates were changed as shown in Fig. 2, which was a great help, still trouble was experienced in keeping the full pressure. A carload of good pea soft coal was placed handy for the fireman, from 6 to 12 scoop shovels an hour of this coal were placed in the dust carrier as it passed the fireman to the top of boilers, thus mixing the coal thoroughly with the wet dust, giving body and life to the sawdust fire, after which no trouble was experienced in getting all the steam needed. No wood was used at all. Before shutting down at night, the furnaces were filled as full as it was possible to get them and this burned out during the night, leaving a full pressure to start on.

Burning the sawdust in this way the expense of carting off the dust not used and the hauling of the five loads of wood with its cost was dispensed with besides having plenty of steam. The writer's experience indicates that the best practice is to have every part of the grates covered, much the same as with coal. Any scheme to work this plan, if simple together with a good draft, will give satisfactory results. Regarding the draft, it is necessary to have it just right, not too strong yet strong enough to do the work properly. In the illustrations, A, A_1 and A_2 are the blast grates; B, sawdust grates; B_2, holes through hollow grates; C, dust holes from dust conveyor to furnaces; D, filling under rearrangement to raise blast grates; E, line of sawdust as it piled up in the furnaces. S. P. MORRISON.

Belting Difficulties Overcome

A MANUFACTURING concern installed a machine which was to be driven from a counter shaft which in turn

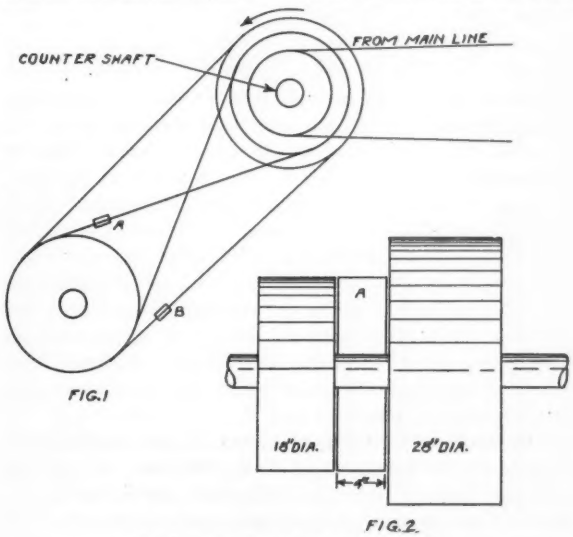


FIG. 1. END VIEW OF BELT DRIVE

FIG. 2. SPACE BETWEEN PULLEYS FILLED TO PREVENT DAMAGE TO BELT

was driven from the main line shaft. The machine in question required two belts, one twisted and one straight.

After the machine was installed and all ready to run, it was found that the belts would not shift when the shifting device was thrown into gear. The whole trouble proved to be in the counter shaft running in the wrong direction. It will be noticed in Fig. 1 that the pulleys on the counter shaft run in the direction shown by the arrow, and the belt shifters on the two belts on the machine are shown at A and B; hence they were located on the wrong side of the belts, making it impossible for them to shift the belts. As neither the shifting device nor the belts could be changed so as to bring the shifting forks on the proper side of the belts, the only thing there was left to do was to run the counter shaft in the opposite direction, by changing the belt driving the counter shaft from main line from a straight to a twisted belt. After this was done, there was no further trouble with the machine belts not shifting as they should.

I have a 6-in. double leather belt in my plant which drives a secondary line shaft from the main line shaft in the factory. This drive had been in service for a long time without giving any trouble, when one day, for some reason, the belt came off the driven pulley and got caught between the pulley driving it and another one located near it and until the engine was shut down, it seemed as if the belt was going to tear down the secondary line shaft.

To prevent this trouble occurring again, I filled up the empty space on the line shaft between the driving pulley and the one located near it, in the following way:

It will be noticed in Fig. 2 that there is a space of 4 in. between the two pulleys where the belt got caught. One pulley is 28 in., the other 18 in. in diameter. As neither pulley could be shifted so as to close up this space, an 18-in. diameter by 4-in. face pulley was bought and placed between the two pulleys as shown at A. Should the belt come off again, there will be no danger of its getting caught between the pulleys.

H. A. JAHNKE.

Welding Cracks in Steam Mains

IN THE August 15 issue of Power Plant Engineering, I read an article by M. M. Brown, describing the welding of a 10-in. steam main, on which I would like to comment.

It is not my intention to question the value of welding because an up-to-date repair unit is not complete without a welding outfit.

I have operated a battery of 18 or 20 Manning boilers in which all the tubes were welded to the lower tube sheet and after years of operation, no trouble has developed. This welding of the tubes, however, was not done for the purpose of supporting the sheet, but to prevent leakage.

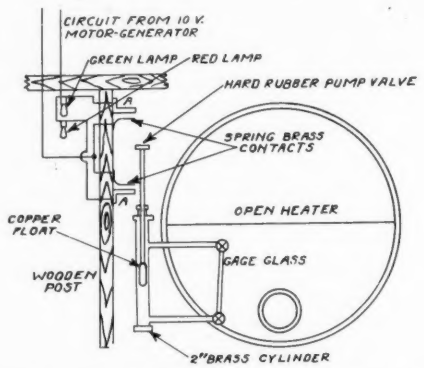
No doubt the welding of a crack around the circumference of the 10-in. steam line which Mr. Brown described will perhaps hold indefinitely but I don't think that welding large high pressure steam mains should be encouraged when the strain must come upon the welded part.

As the difference between the cost of welding and the price of a new pipe is only $50, it is obvious that the welding should be temporary and a new pipe ordered.

R. G. SPOONER.

High and Low Water Alarm for Feed-Water Heater

IN A MANUFACTURING plant in New York City, the boilers were fed from an open heater through either of two triplex pumps, driven by electric motors, or, by a duplex steam pump. The steam pump was controlled automatically, the others were not. It was found to be more economical to feed the boilers with the electric pumps when the plant was operating. The valve controlling the make-up water was handy to the boilers, but the fireman was obliged to go about 50 ft. to the far end of the heater, in order to see the gage glass. The fluctuation in the water level in the heater was often very sudden, due to the irregular use of steam in



FLOAT ARRANGED TO MAKE CONTACTS AT HIGH AND LOW WATER MARKS

the manufacturing processes, either flooding the heater, or if it got empty, causing the pump to race. With material found in the scrap-pile, a device was made to warn the fireman in time to control the make-up water, or regulate the speed of the pump.

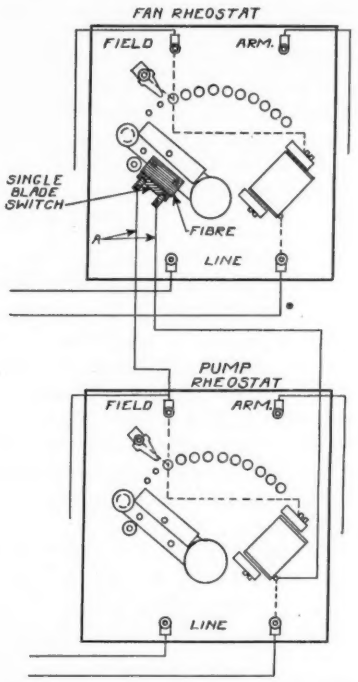
A cylinder was made of a piece of 2-in. brass pipe capped on the ends. On the top end the stuffing-box from an old globe valve was soldered. A copper float was attached to a ⅜-in. brass rod, and sufficient weight added to pull it down through a light packing of lamp-wick. To the top end of the rod, a 2-in. hard rubber pump valve was fastened with a screw. Two brass brackets (A, A in sketch) were secured to a wooden post, and a wire soldered to each ¼ in. from each bracket, a spring-brass contact strip (B, B) was fastened to the post, in like manner, and wire soldered to each. On a board, in plain sight of any part of the firing floor, two 10-v. lamps were secured. One of the lamps was red, the other, green. A circuit was run from a 10-v. motor-generator set. One wire was connected to each lamp socket; the other, to each spring contact strip. The other sides of the lamp-sockets were connected to the brass brackets. Now, when the water level reached the height for which the device was adjusted, the rubber bumper on the end of the road pushed the spring contact strip against the bracket, thereby closing the circuit on that lamp. As long as neither lamp was lighted, the fireman knew that his water level in the heater was normal, but when either lamp lighted he could regulate the water-level immediately, and without taking 10 steps. This device worked perfectly, requiring only an occasional cleaning of the contacts. M. M. BROWN.

Automatic Release for Pump Rheostat

THE ACCOMPANYING sketch shows the connections made for obtaining the automatic release of the pump rheostat if for any reason the fan rheostat should be shut off.

The two are part of an air conditioning apparatus and it was found to give some trouble if the pump ran without the fan; hence the automatic arrangement.

A piece of sheet fibre is fastened to the arm of the fan rheostat as shown and to this is fastened the blade



CONNECTIONS FOR AUTOMATICALLY RELEASING PUMP RHEOSTAT

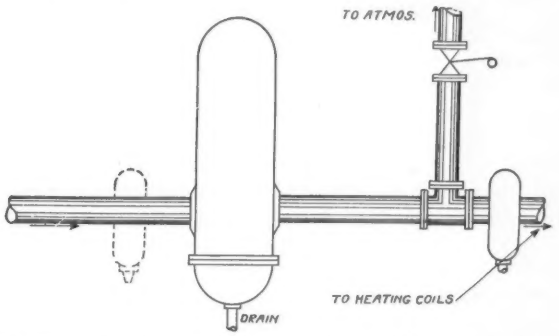
of a single pole switch. Clips to receive the blade are fastened to the front of the rheostat. Leads A are connected to the release coil on the pump governor. When the handle of the fan rheostat is in "stop" position the single blade switch short circuits the release coil of the pump rheostat, not allowing that to hold its starting handle in running position.

GEO. B. LONGSTREET.

Saving Drips From Closed Heaters

SOME TIME ago, the writer took in hand a small 100-hp. plant for the purpose of putting it in more efficient shape, and one of the many apparently obvious, but still neglected economies was made in connection with the feed heater layout, which was roughly as shown on the attached sketch, the closed or tubular feed heater being installed in the 8-in. exhaust line from the engine and pumps leading to the heating system, with a 6-in. riser to atmosphere. The surplus exhaust was used in a heating system which line had installed an 8-in. oil extractor to remove oil to make the condensate usable in the boilers. This heating system condensate was being returned to the hot well. We noticed that considerable make-up water had to be admitted to the hot well, and investigation showed that the drips from the closed heater were being thrown to waste because of oil contamination. Obviously this drip water could be saved if the oil was eliminated, and it was worthwhile to try for this saving, for on a rough test we made on measuring this heater drip we found it to amount to about a barrel and a half per hour, or about 50 gal.

It did not take long to decide what to do—we merely took the oil extractor from its original location on the heating system inlet, and moved it along the exhaust line, putting it ahead of the heater, so that all the steam would be cleaned and all the condensate could be used. We then cut the heater out of service, and boiled out the coils with a light caustic solution to remove the accumulated oil, following which we put the unit in service, wasted the returns for several days, and then connected the drip into the hot well, effecting quite a nice saving in the city water bill. It would be well for



SKETCH SHOWING HOW OIL EXTRACTOR WAS PLACED AHEAD OF HEATER

all users of these tubular heaters to look into the possibilities of saving the drips, for as a general rule they represent excellent opportunities of real savings.

M. A. SALLER.

Care of Commutators

MY EARLY training in the care of electrical apparatus was received in 1903 while serving an apprenticeship with an electrical manufacturing company who made a specialty of direct current motors, generators and control appliances. It was my duty, while taking the testing room part of the course, to inspect and clean the direct current motors (some 60 in number) each week, these motors being scattered throughout the works on various machines and equipment. I was instructed to stop each motor, and use No. 00 sandpaper to smooth up and remove the glaze on the carbon brushes, and also sand the commutator unless it presented a good chocolate colored polished surface, free from scratches, or signs of sparking. It was of course necessary to run the motor to sand the commutator. The motor was then wiped clean and the oil in the bearings inspected, after which the motor was put back in service and a piece of rag with a little good vaseline on it applied to the commutator to provide lubrication. In a short time the commutator would work up a good brown polish, that is if it had been necessary to disturb the former surface in removing scratches or black spots.

In no case were we ever instructed to do any slotting out of the mica, in fact, in those days I do not recall

seeing any slotting done on any commutators. We were cautioned, however, to look out for any bearings having a tendency to throw oil which might work up on the commutator. I do not remember a single case of sparking which was caused by high mica, as the company used a good grade of soft amber mica for insulation between the commutator segments. Occasionally it was necessary to remove the armature and have the commutator trued up in a lathe, but these cases were rare and generally only happened after excessive sparking, caused by overload, had occurred over an extended period.

Since leaving the factory I have run onto commutators which behaved badly, and in every case where slotting has been resorted to we were sorry for it afterward, as the carbon and copper dust would collect in the slots and the tendency was always for the slots to get deeper each time they were cleaned out. Then, too, I believe that slotting has a tendency to produce vibration of the brushes, in some cases more than others, depending to some extent on the style of brush holder used, and the relative thickness of brush and segment, etc.

At present I have three 7½-kw. and one 10-kw. interpole exciters in my care. Originally the first three machines were fitted with bronze bearing bushings which behaved fairly well except that they would wear the shaft a great deal more than a babbit lined boxing would. In case of a hot bearing the bronze would generally scratch up the shaft pretty badly, necessitating truing up in a lathe.

All of the four armatures (one is a spare) belonging to the three 7½-kw. machines have had their shafts trued up, new babbit linings substituted for the bronze linings, and the commutators turned down enough to get rid of the slotting between the segments. I was particularly careful to fix up the shaft centers before putting the armatures in the lathe, as these had been scarred up at previous times when removing pulleys.

We purchased a commutator truing stone at a cost of $2.50. This stone is about 2 in. square by 10 in. long and is of a medium grade, light gray in color. We have cut it up into the shapes and sizes most convenient to handle and if it is suspected that a commutator has high mica or is out of round, the stone is used to remedy the trouble. It is very important that the stone be properly applied to the commutator. If too much pressure is used or if the stone is not held firmly against the brush holder bar or other suitable guide, it will have a tendency to follow the hills and hollows of the commutator face, resulting in a job which is not perfectly round. Start in by holding the stone firmly against the guide and gradually work it down till it barely touches the copper. Continue to work the stone down slowly till a small section of the commutator face is trued up. This will be, say, ¼ to ½ in. wide. Then shift the stone over and start on the next section. After the entire face has been trued up, the small ridges, if any, between the sections, may be removed by lightly grinding them off with a wider portion of the stone.

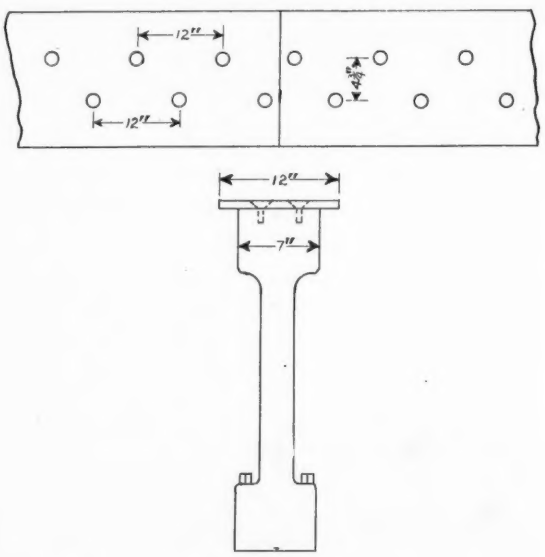
This method, if carefully followed out, gives a perfectly smooth, round commutator, whose center is exactly the same as the shaft or bearing center, and is much superior to turning the commutator in a lathe, since the lathe tool is sure to vibrate slightly in passing over the alternate layers of copper and mica. The lathe may be used, however, if the commutator is badly out of true, and the grinding job will be made shorter if there is not too much copper to be removed. The stone should be the final application in any case before calling the job complete.

After being put in service, then, if sparking recommences, after a time, it is pretty certain to be high mica, and the stone will fix it up in a short time if the first job of getting the commutator round was carefully done.

Oil getting on a commutator tends to carbonize the mica insulation, causing partial shorts, which in turn cause heating and a failure to produce the proper voltage. A good remedy for this evil is first to stop the bearing from throwing oil if possible, then clean out the blackened mica with a thin saw blade, fill in the spaces with a good commutator cement, and shellac the end of the commutator and as much of the face as possible without interfering with the surface in contact with the brushes. WALTER J. STEWART.

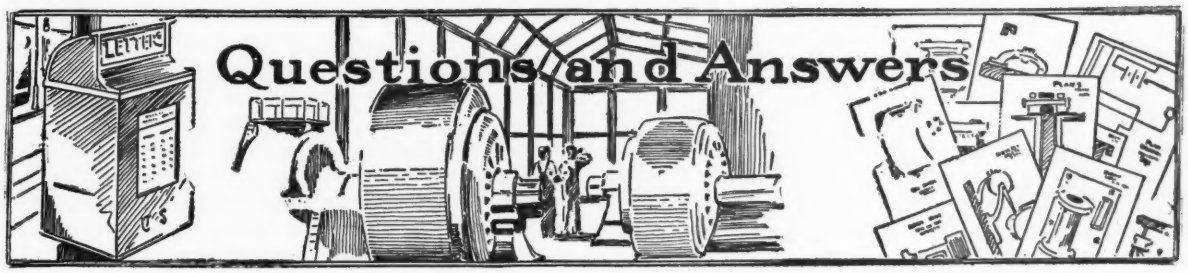
Converting Flywheel Into Belt Wheel

THE WRITER had the problem of changing a steam driven ammonia compressor to motor drive. This compressor had a 60-in. diameter flywheel with a 7-in. face. With motor drive this 7-in. face was insufficient for the belt, which required a 12-in. face. The cost of a new flywheel with 12-in. face was prohibitive so it was decided to use the present wheel. A piece of steel 12 in.



PLAN OF BAND AND SECTION OF FLYWHEEL

wide ½ in. thick, the length equal to the circumference of the wheel plus three times the thickness of the metal was drilled with two rows of 9/16-in. holes 12 in. apart in row and staggered. These holes were then countersunk to fit ½ in. by 1⅝ in. countersunk head bolts, the sheet was then rolled in a ring to the diameter of wheel. The ring then slipped over the flywheel, made an exact fit at ends. An electric drill was used to drill holes in rim of flywheel through the holes in the ring. Drilling, tapping and bolting completed the job, which since has given satisfactory service. AUGUST GASS.



Condenser Questions

IN THE July 15 issue, on page 726, F. W. R. has some interesting material that engineers do not agree on. I should like to see comments from engineers on this subject.

The first question: "What would be the result if a 1-in. hole were drilled in the tail pipe of a barometer condenser at the level of the hot well?" If this hole were at the level of the overflow there will be no ill effects. If the hole were 5 ft. above the level of the hot well, the engine can easily be flooded by the atmospheric pressure acting on the water in tail pipe through the 1-in. hole. I wonder if F. W. R. believes that atmospheric pressure, say of 14.7 lb., can act through a 1-in. hole, and cause the water in an 8-in. tail pipe to stand 5 ft. higher, where there is a difference in areas of about 50 to 1. The water is constantly falling and would have a tendency to carry the air with it. The air in the water that is effected is between the hole and the end of the tail pipe.

2. With the extra 5 ft. elevation which would equal 35.375 ft., it is easily seen that the water would go over to the engine. The question is would the air gradually work its way to the top of the condenser, and destroy the vacuum, or would it go up as a slug? The whole body of water would be higher, due to the decrease of weight of water between the hole and the tail pipe outlet.

Engines have been damaged by water when barometric condensers have been used; this could happen if you had a leak high and large enough in the tail pipe. But I believe that most accidents are caused by the throttle being closed before the exhaust pipe has been properly drained; the piston in this case acts as a pump, and the water is trapped in the cylinder. F. C. E.

Ground Detector Action; Series Field Shunt

THE ACCOMPANYING sketch shows the manner in which our switchboard is connected up. As will be noted, there are three bus bars, the positive, the negative, and the equalizer bus. The negative bus is grounded and a ground detector consisting of two lamps in series is connected as shown. Two pilot lamps are also connected across this ground detector circuit. One of the ground detector lamps always burns brightly, while the other one is always dark.

I would like to know whether these lamps are connected correctly. As I understand it, when two ground detector lamps are connected in series with a ground connection at the center, both lamps take half voltage and as a consequence, both burn dim. If a ground occurs on either side of the line, the lamps connected to the opposite side of the line will burn bright.

Can you explain why the middle wire on the public service line is grounded on our negative bus bar as shown? This public service line is a three-wire, alternating current system which is connected to our double-pole double-throw switch for lighting purposes at night, when our generators are not operated.

I would also like to have you explain the action of the resistance strap on a compound generator. H. S.

A. With the negative bus grounded as shown in your diagram, the ground detector becomes useless, as it will constantly indicate a ground on the negative bus. Except in the case of special applications such as railway work, it is not necessary to ground this negative bus. Your interpretation of the action of the ground detector is correct.

We see no reason why the middle wire of the public service line should be connected to the negative bus of your direct current system. If the alternating

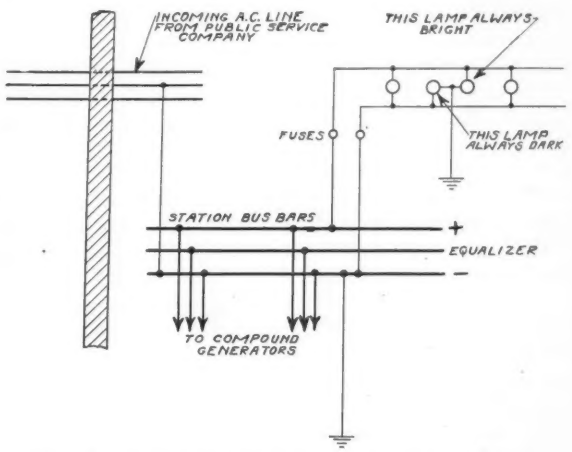


DIAGRAM SHOWING CONNECTIONS OF SWITCHBOARD

current system is intended to be grounded, a separate ground connection should be provided.

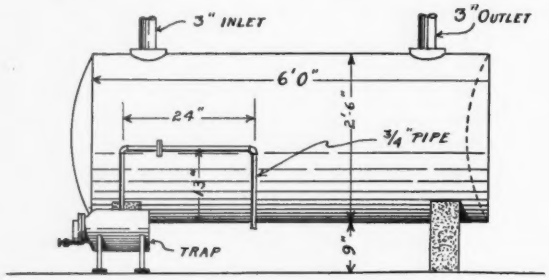
In the operation of compound generators in parallel, each machine must be adjusted separately to give to same degree of compounding by means of a low resistance shunt across the series fields. By means of these shunts the compounding effect of the series winding may be regulated by shunting more or less of the armature current past the series coils. In other words, instead of the entire armature current passing through the series field, it divides part of it going through the winding and part through the shunt. The lower the resistance of the shunt, the greater will be the amount of current taken away from the series field.

NEW HYDROELECTRIC central stations under construction in Italy have capacity of 1,811,330 hp. in 54 plants.

Trap Installation

On page 775 of the Aug. 1 issue of Power Plant Engineering, A. G. H. submits a question on trap installation such as shown in the accompanying figure.

His first question: "Will the trap as installed, keep the receiver free from water or will the water in the receiver rise 13 in. (the height necessary to fill connecting pipe to trap) before the trap will operate?" When the trap opens the outlet valve, the steam pressure of 125 lb. will force all the water out of the receiver. After the trap closes, the water will have to rise 13 in. before the trap will open again. Water will find its level under



RECEIVER AND TRAP INSTALLATION

the same pressure, therefore in this installation the water will rise in the receiver until the trap opens.

"What effect will the condenser action of the trap have on its operation?" In the trap shown, the condenser action will not amount to anything.

"Is it ever proper to set a steam trap above the coils it serves?" No. If it is so placed, the coil will be water logged. They will fill up with water to the level of the operating point before the trap opens. F. C. E.

The questions raised by A. G. H. in the Aug. 1 issue, are certainly pertinent in so far as steam trap installations affect the operation of any steam using equipment or apparatus.

A steam trap is really a drainer that is intended to remove the water resulting from the use of steam. The water or condensate may be caused by radiation, transmission, friction or a combination of them all. As the water in the steam vessel falls to the lowest point of the pipe, the coil, the special appliance or other apparatus, it would naturally follow that in order to drain this water away, the steam trap intended for this purpose must be placed at the lowest point.

In the problem presented, a receiver is used as a means for separating the water from the steam. The object, undoubtedly, is to prevent such slugs of water as may be brought over from the boiler or have been entrained in the connecting pipe from being carried over into the apparatus that is using the steam. In other words, steam storage, equalized flow and drier steam is required. To this end, a float type steam trap is employed to drain off the water. A trap of this style is supposed to drain continuously, so that it should remove the water as fast as it comes in, whether in dribbles or in heavy slugs.

The way the trap is shown connected, the object for which it is intended, is actually defeated. There is established a water line in the receiver equal to the height of 13 in., and it means just that much water in the tank. While the pressure in the receiver is more than sufficient to clear the trap line, during operation, it takes steam for the purpose, and this steam is in turn wasted into the sewer, through the trap discharge. When the system is at rest, as when shut down, the receiver will contain water to a height of 13 in., and when starting up again, this reservoir of water may be the cause of trouble; and of course the trap does not function then, so is therefore practically useless. The condensing action of the trap even when operating probably will not cause sufficient vacuum or suction to be of much aid.

Another point of disadvantage is the size of drain connection used. This should be 1½ in., or still better, 2 in., rather than the ¾-in. shown in the sketch. Then again the number of turns in the small pipe acts as a resistance that would also interfere with operation.

Certainly the installation illustrated cannot be considered good engineering. In order to drain anything, the operation must be from the lowest point, particularly when it is done by gravity, for reasons of safety and economy. It follows, therefore, that it is never proper to locate the inlet of a steam trap higher than the lowest point of the steam vessel it is supposed to drain. M. William Ehrlich.

Without any question of doubt, the method shown in A. G. H.'s illustration is a dangerous method; however, while there is 125 or 160 lb. pressure to the square inch on the receiver no condensation will remain in the receiver because the pressure will force the condensation on the lower part into the trap, provided, of course, that the trap is in good working condition. According to the sketch, there is no means of draining the condensation from the receiver when the steam line leading to the receiver is closed.

This method of connecting a condensation trap 13 in. above the lower part of a receiver will give splendid results while the pressure mentioned is on the receiver, but if ever the steam pressure is closed off on the line leading to the receiver the steam left in the lines leading from the receiver will condense and flow back into the receiver, and experience has shown that valves do not always close tight. A leaky valve will add more condensation to the receiver, causing the condensation to rise 13 in. in the lower part of the receiver. There would be no pressure to force it out past the trap. It is not likely there is a partial vacuum in the sewer pipe connections to drain the condensation. There may be also a partial vacuum in the receiver which would prevent the condensation from flowing past the trap, and when steam is again turned on, it would come in contact with the condensation which is left in the receiver, causing such a water hammer that it is doubtful whether all the parts would remain intact. It is never proper to connect a steam trap above the coils it serves unless there is a drain outlet at the lower point; but this is not safe, as the drain valve is liable to be forgotten. P. J. Molloy.

Starting Generators in Parallel

An inquiry was published in the July 1 issue of Power Plant Engineering requesting an opinion on the proper method of starting up three 625-kv.a. turbo-generators in parallel.

The most important point in warming up the turbine is not to crack the throttle and blow steam through the turbine with the motor stationary. Open the throttle and start the rotor turning at once. Then reduce steam to about 30 lb. while turbine is warming up.

Start the second and third machines in a similar manner. Now put the gland seal on No. 1 turbine and bring it up to speed, non-condensing. When the governor comes into operation, put on the condenser. It is important that the operator should stand by the throttle until the governor controls the speed. If the condenser is put on with the turbine somewhat under full speed, and the governor fails to operate, a dangerous condition of over speed would quickly be reached. Finally open throttle wide on No. 1 turbine.

Now, proceed in a similar manner with the second and third turbines.

The three generators can be put on the switchboard without load or as the load comes on, as appears best under the existing conditions. It was not stated which exciter carried the load. After starting with the steam exciter, if the exhaust steam is not required the motor exciter should be used. R. N. ANGEVINE.

Would the Installation of a Condenser Be Advisable?

IN THE July 15 issue, R. H. S. asks about the advisability of installing a condenser on a plant with a simple engine where some of the power is furnished by water. For the cooling surface, his method is to place a bank of pipes in the flume and use an air pump to remove the air and condensate.

Before estimating the relative economy of such an installation, it is necessary to know the size of the engine, the boiler pressure carried and the time that the engine is operated. If the diameter of the cylinder is less than 15 in., it is doubtful if the installation of a condenser would pay, so it will be assumed that the engine is larger than that mentioned.

The bank of pipes would act the same way as a surface condenser and if the feed water was poor, this would provide better water, which would make for better general economy of the plant. Otherwise, a jet condenser might be lower in cost than the piping when the labor of installing is considered. For cooling surface, probably about 3 sq. ft. per hp. would be necessary and the power required for the air pump would be about 2 per cent of the power developed at normal load.

Since exhausting into a vacuum of 20 in. would have about the same effect as adding 10 lb. to the boiler pressure, it follows that the cutoff will be earlier for the same load thereby saving a certain amount of steam.

From a table prepared by the Worthington Pump and Machinery Co., it is computed that with steam at 90 lb. gage, the engine cutting off at ¼ stroke, and a vacuum of 26 in., the gain in power, without considering clearance or compression, would be approximately 25 per cent.

Assuming 20 per cent gain to be conservative and subtracting 2 per cent for steam to the air pump, we have 18 per cent net gain.

If the engine in this case is developing 200 hp. with a water rate of 25 lb. per hp., it would require 5000 lb. of steam per hour; 18 per cent of this would be 900 lb., and if the evaporation from one pound of coal is 8 lb. of water, about 112.5 lb. per hr. would be saved by the use of the condenser; for 10 hr., 1125 lb., which, with coal at $6 per net ton, would mean a monetary saving of $3.48 per 10-hr. day.

If the cost of installing the condenser were $1000 and the interest on the investment were 6 per cent, which would be $60 per year, depreciation 5 per cent, or $50 per year, and all other charges 3 per cent, or $30 per year, we would have a total of $140 per year expense. For 3000 working hours per year, the amount of coal saved would be worth $1044. So it is apparent that there will be considerable saving if the plant is about the size mentioned above. G. H. KIMBALL.

Flywheel Design

WHAT SIZE and weight flywheel should be used to keep our prime mover within a reasonable speed range during the application of a variable load? We have a line shaft running at 450 r.p.m. driving a 60-in. saw, a 24-in. hog edger with two saws, log chain conveyor and other small machinery amounting to 150 hp. This shaft is driven from a 250-hp., 2200-v., 900-r.p.m. induction motor. C. C. R.

A. The size and weight of a flywheel to be used in this installation will depend on the magnitude of the variable load, the speed fluctuation allowable, and the speed at which it is to run. Experience has demonstrated that for work of this kind a speed fluctuation of, say, 5 per cent (2.5 per cent above and below normal speed) may be allowed. From the question, it is to be inferred that the magnitude of the variable load amounts to 100 hp. If we assume that the load is applied during one revolution and that the flywheel is to be put on the motor shaft, running at 900 r.p.m., we may determine the weight of wheel required. The work to be done by the flywheel in one revolution in slowing down 2.5 per cent will be $100 \times 33{,}000 \div 0.9875 \times 900 = 3720$ ft. lb.

Ordinarily the maximum speed allowed on cast iron flywheels is about 100 ft. per sec. If we assume this to be the normal rim velocity, we find that the radius of our wheel will be

$$R = 60 \times V \div 6.28 \times N$$

Substituting 100 ft. per sec. per V and 900 r.p.m. for N, we find the radius to be 1.06 ft. or say 12½ in. The weight may be found from the equation

$$W = 2g \times E \div (V^2 - V_1^2)$$

where g is the acceleration due to gravity, 32.2 ft. per sec. per sec., E is the energy given up during one revolution, 3720 ft.-lb., V is the initial velocity, 100 ft. per sec. and V_1 is equal to $0.975 \times 100 = 97.5$ ft. per sec. Substituting in the equation, we have

$$W = 64.4 \times 3720 \div (10{,}000 - 9506.25) = 485 \text{ lb.}$$

As cast iron weighs 0.26 lb. per cu. in., the volume of the rim of the wheel will be $485 \div 0.26 = 1860$ cu. in. The volume of such a rim is

$$V = 3.14 \times t \times (2r - t) \times w$$

where t is the thickness and w the width of face. Assume for instance that the thickness is 5 in., then we may solve for the width

$$1860 = 3.14 \times 5 \times (25 - 5) \times w$$

from which $w = 1860 \div 314 = 5.92$ in. or say 6 in. We have then a 25-in. wheel with a 5 by 6-in. rim.

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Coal Problem Still Serious

Since the last issue of Power Plant Engineering was published, the coal strike has been settled by working agreements whereby the miners in both the bituminous and anthracite fields have gone back to work and the latest report from the Geological Survey would indicate that production of bituminous coal is back nearly to the average for this time of year.

As the soft coal situation stands now, the production this year to date is 31,616,000 T. lower than it was last year at this time and last year production was considerably below what has been considered normal since the years before the war.

So here we have it, a large group of men ceased to work at their regular employment for a period of 20 weeks, fortunately during a season of the year when coal is in least demand; many industries throughout the country have been forced to close their doors for lack of fuel, putting many others out of work; numerous power plants have been obliged to substitute other fuels for coal in order to tide them over the period of coal scarcity.

The expense to which fuel users have been put by this strike can probably never be estimated and it will be a long time before fuel users will get out from under the expense of this strike. Coal prices have gone up and in all probability will continue to increase until stocks are replenished to their normal condition.

Within a week's time, the limiting element in the production of coal has changed from lack of workers to lack of railway cars for transporting the coal mined, and this is a condition which is bound to continue throughout the fall even if the strike of the railway shopmen should be ended within a few days; for at this season of the year, large numbers of railway cars are demanded for the movement of grain crops.

From the economic standpoint, the results of this strike would appear to be that everybody has lost; miners have lost time and wages; operators the interest on their investments and expense of keeping their property in condition for operation; fuel users, among whom the power plants of the country are important, have paid and will continue to pay unnecessarily high prices for coal. The miners and operators may possibly make up their financial losses, but the consumers never can.

Strikes such as have been conducted in this country can have but one beneficial result and that is to force parties to the controversy, who have not been willing to deal justly, into a frame of mind where they will be reasonable, as the public sees it. Judging from this standard, the strike has been a failure.

It is, therefore, apparent that the coal situation is still a serious problem and power plants that are fortunate enough to have coal in storage will do well to hold a good supply in reserve until commercial stocks have been replenished, so that the possibility of shortage has passed.

High Steam Temperatures

The attainment of great and yet greater efficiencies and economies in the generation and utilization of steam has ever been the chief concern of the steam and combustion engineer. According to Rankine's equation for thermal efficiency of a heat engine, the higher the initial and

the lower the final heat content of the steam, the greater will be the efficiency. Final pressures have been reduced to an economical minimum at about ½ in. of mercury but at this pressure the heat content will of course vary with the quality of the steam which may vary considerably according to initial conditions of pressure and temperature and also according to the way in which expansion takes place.

As to initial conditions, the tendency has been to increase both the pressure and temperature. To this end, valves and other parts coming into direct contact with the steam have been designed to withstand severe high pressure and temperature without deformation.

Aside from the limitations imposed by the structural design of the prime mover, there are certain combinations of pressure and superheat that will give better results than others for a given amount of energy originally imparted to the steam. The problem then is to determine just what combinations are best adapted to the purpose at hand.

On another page of this issue, this subject is taken up in a comprehensive manner. Comparisons are made with constant heat content, the pressure and temperature varying; constant temperature, the heat content and pressure varying; and constant pressure, with the heat content and temperature varying. Data is presented largely in the form of tables and charts and is readily usable. Pressures up to 800 lb. per sq. in. and temperatures to 900 deg. F. are considered.

Heretofore engineers have advocated higher superheat and more recently perhaps, higher pressures also. In the light of Mr. Polson's article, however, it would appear that arbitrarily to determine the pressure and temperature to be used is insufficient. There are certain fairly definite combinations that should be used with every kind of prime mover for every condition of operation. For instance, a certain turbine expanding steam according to a certain law to a given back pressure will require different initial conditions from one expanding according to some other law to some other final pressure; or different again from a reciprocating engine operating under other conditions. As is the case with most engineering problems, each case must be solved for itself on its own merits.

Does a College Education Pay?

This morning we received a letter from a young man who wants to be a chief engineer in a large central station and would like to know whether or not it would be necessary for him to take a college engineering course to fit himself for the job.

It cannot be said that an engineering degree is necessary to fit one to hold such a position, because such positions are being filled today by men who have not a college education; but it would certainly appear that such training would be a wonderful assistance to anyone aiming for that goal.

An education should be considered as a means to an end and not in itself, an end. It is true that many view it in this light, but the idea is fundamentally in error. An education should be used as a tool; a tool to be used to accomplish something in a better way than would otherwise be possible.

Take the case of the chief engineer's job; all the necessary information and experience could be obtained through years of working in the power plant, but an engineering course would enable a man with the same amount of brains and ambition to arrive at his goal in a much shorter time. Besides this, he would probably be equipped with a broader understanding of fundamental principles which would lead him further yet.

Practical experience is always necessary with or without a formal education. The difference is that a man who has been trained to think logically is able to interpret his experiences and data to better advantage. He does not need as many experiences of the same nature to tell him what to expect in the future under similar circumstances. By connecting up his observations with his knowledge of the fundamental laws of nature, he is able to predict just what will happen under a given set of conditions; he thus develops a certain amount of foresight, a quality valuable to anyone in any position.

As a general rule, it may be said that any investment in one's self is likely to bear interest that, from almost any point of view, will be well worth while.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

In an address before the convention of Rotary Clubs at Los Angeles, Preston S. Arkwright, president of the Georgia Railway and Power Co., emphasized the trend toward increased government control of public utilities and coal mining. He cited the course of control in the case of the railroads, and the bad effects it has had on them, consequently on all industry.

He said, "Security from the possibility of government control is a delusion. Any business or industry will be held to so affect public interest as to justify control if public sentiment demand it." He deprecated such control, and urged as a means of avoiding it that, "Determination among men interested in business to give value as well as take it, realization that one class cannot profit at the expense of another without eventual loss to both—is needed today." He urged also that all men take interest in doing away with unfair practices by all engaged in their industry by taking part in local, state and national associations and in public affairs in order to square the practice of business with fair dealing and sound economies. "Men sacrifice their own interest and shirk the responsibility of citizenship by failure to do so."

Analysis of the gases arising from the fuel bed of a forced draft chain-grate stoker, in tests being conducted at Pittsburgh, Pa., by the Bureau of Mines, shows that large quantities of combustible gases rise from the central portion of the grate, while near the back much excess air and little combustible gas are present.

The Cadillac Condensation Meter

A NEW CONDENSATION meter has recently been developed and placed upon the market by the Central Station Steam Co., of Detroit. This meter, a photographic view of which is shown in Fig. 1, is a volumetric device for accurately and continuously recording the quantity of steam used for heating or other purposes.

A cylindrical copper drum, which is the true measuring element, rotates on roller bearings in a cast-iron case, the rotary motion being transmitted to an integrating clockwork counting mechanism.

Figure 2 illustrates the principle of operation. Water is admitted to the revolving drum by means of a spout introduced axially at the center of the drum, but not connected to it. In the bottom of the spout and extending lengthwise, is a slot through which the water passes to each compartment successively as the drum rotates.

The diagrams show the manner in which the water

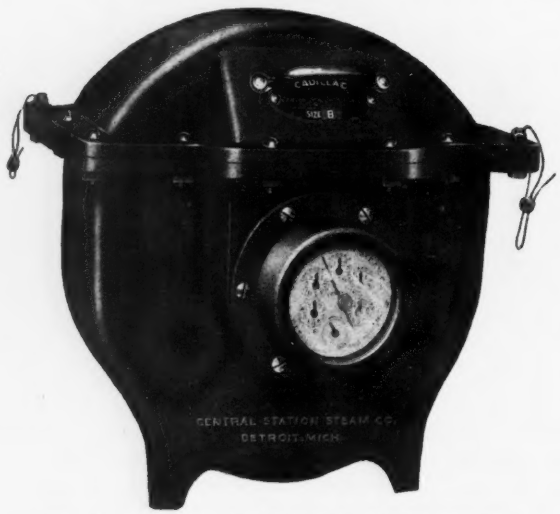


FIG. 1. THE CADILLAC CONDENSATION METER

causes the drum to revolve. Starting with compartment No. 1 directly beneath the spout, the incoming water gradually fills it and by the peculiar shape of the compartment causes the greater portion of the water to flow to one side of the perpendicular center line. By seeking to find the center of gravity, the water turns the drum until finally, when compartment No. 1 is full, the weight and location of the water has drawn compartment No. 2 beneath the spout opening.

The second compartment fills in its turn and draws compartment No. 3 into place and the water in compartment No. 1 now begins to overflow at its outer opening in the perimeter of the drum. Compartment No. 1 does not commence to discharge until compartment No. 3 is partly filled. The shape of the compartments is such as to prevent any surge in the water and as a consequence the motion of the drum is steady and continuous.

The meter is built in two types—gravity and vacuum. The gravity type meter has a case which is not air tight and is intended for use on heating systems where the condensate flows away by gravity either to a sewer or container. The vacuum type instrument is a modification of the gravity type, gaskets being provided at all joints to seal the casing. A special counter housing is also provided for vacuum service. The gravity type counter housing is fitted with a wiper dial-glass,

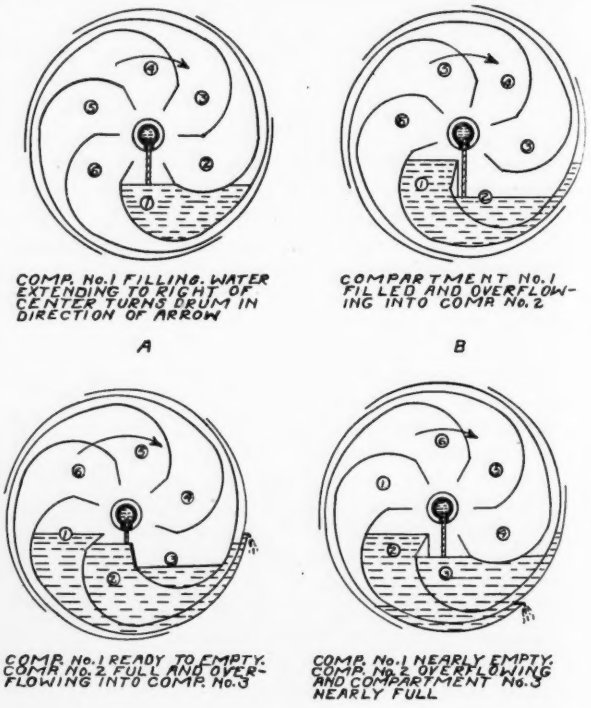

COMP. No. 1 FILLING. WATER EXTENDING TO RIGHT OF CENTER TURNS DRUM IN DIRECTION OF ARROW
A
COMPARTMENT No. 1 FILLED AND OVERFLOWING INTO COMP No. 2
B
COMP. No. 1 READY TO EMPTY. COMP No. 2 FULL AND OVERFLOWING INTO COMP. No. 3
C
COMP. No. 1 NEARLY EMPTY. COMP. No. 2 OVERFLOWING AND COMPARTMENT No. 3 NEARLY FULL
D

FIG. 2. DIAGRAMS ILLUSTRATING OPERATION OF METER

held securely in place from the inside by a phosphor-bronze jump ring. The vacuum type housing is provided with a plain dial-glass which is pressed tightly against its gasket by a threaded brass retaining ring. A special feature of the vacuum housing is the means provided for clearing the glass of vapor. On top of the

FIG. 3. DISASSEMBLED VIEW OF METER

housing is cast a boss in which is recessed a headless set-screw. By backing off this screw (or air valve) one or two turns, a current of cool air from a side passage is drawn across the inside of the glass, clearing the vapor in from 10 to 20 sec.

DRAFT LOSS as found from experiments is as follows for breechings of an area to give not over 30 ft. per second gas velocity: right angle turns, 0.05 in. water pressure; horizontal runs, 0.1 in. per 50 ft. of run; connection to stack, 0.05 in.; chimney friction, 0.001 in. per foot of height.

New Spray Nozzle

YARNALL-WARING CO., of Philadelphia, has recently extended its line of cooling equipment by the addition of a new and ingenious spray head, known as the Yarway Involute Spray Nozzle.

This nozzle is the invention of Wm. H. Klein, superintendent of the Dixie Portland Cement Co., at Richard

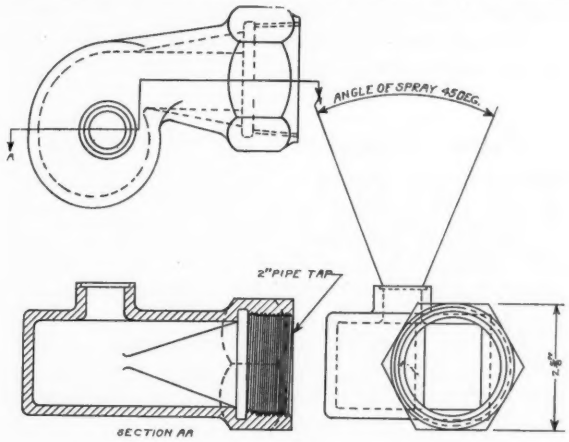


FIG. 1

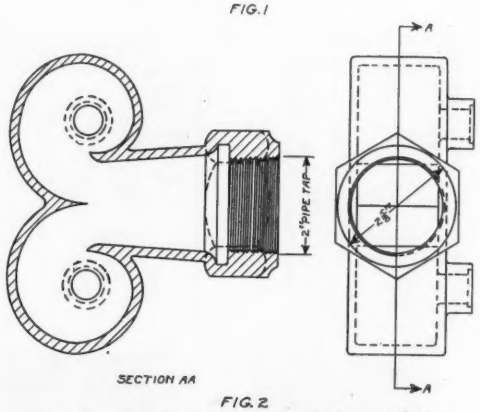


FIG. 2

FIG. 1. YARWAY INVOLUTE SPRAY NOZZLE
FIG. 2. YARWAY DOUBLE INVOLUTE SPRAY NOZZLE

City, Tenn., and is unique in that it has no internal parts or vanes. The contour of the body is such that

TEST DATA ON YARWAY SINGLE AND DOUBLE INVOLUTE NOZZLES

Press. lb. per sq. in.	T_1 Water in	T_2 Temp. out	T_1-T_2 Cooling Range	T_w Wet Bulb	T_a Dry Bulb	$\frac{T_1-T_2}{T_1-T_w}$ = E Efficiency %
SINGLE NOZZLE						
5	114.2	85.5	28.7	67.8	79.8	61.8
6.96	120.5	81.9	36.6	68.2	79.2	73.8
9.9	114.6	83	31.6	68.5	80.2	68.1
9.9	99.6	78.5	21.1	70.3	78.8	53.7
6.96	100.2	80.3	19.9	69.8	78.9.	65.5
DOUBLE NOZZLE						
9.51	110.6	79.2	31.4	67.3	78.8	70.2
6.99	107.6	83.2	24.4	69.5	80.9	63.4
5.1	110.2	88.6	21.6	69.6	81	53.2

the water traveling in an involute path is ever deflected towards the orifice which is accurately located in the top of the body casting so as to uniformly receive the water at the point of maximum velocity and distribute it in the form of a cone of finely divided spray.

The double nozzle shown in Fig. 2 has two orifices which provide two vertical cones of spray which partially interfere and break up the water drops still finer than in the case of the single head. The accompanying

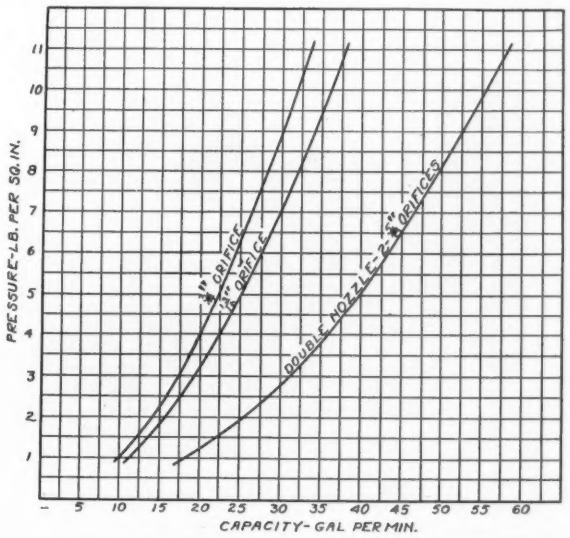

PRESSURE-LB. PER SQ. IN.
1 2 3 4 5 6 7 8 9 10 11
5 10 15 20 25 30 35 40 45 50 55 60
CAPACITY-GAL PER MIN.
1" ORIFICE
¾" ORIFICE
DOUBLE NOZZLE-2-¾" ORIFICES

FIG. 3. NOZZLE CAPACITIES AT VARIOUS PRESSURES

chart shows the relative capacities of the two forms at different pressures and the table gives data on the cooling efficiency from tests made at Johns Hopkins University at Baltimore, Md.

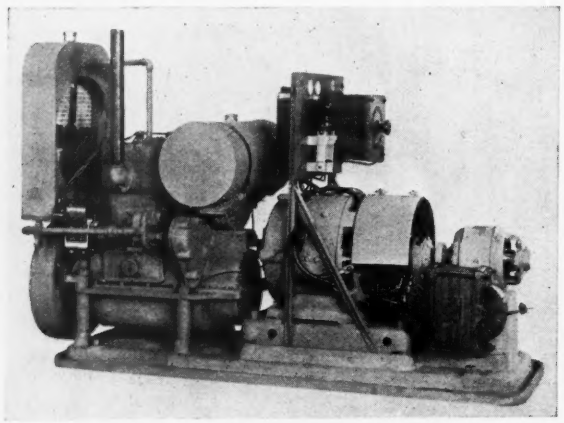
The important feature of these nozzles is the clear unobstructed passageways which do not allow the accumulation of foreign matter which would result in stoppage.

Gasoline Engine Driven Welding Set

AN ENGINE driven welding equipment for use where electric power for motor drive is not available and for job welders who must work in widely scattered districts has been developed by the Westinghouse Electric & Manufacturing Co. This apparatus, which is made in stationary and portable models, also has the advantage of making it unnecessary to waste time applying for a permit or making proper connections before work can be started.

The equipment consists of a single operator welding generator geared to a Doman four-cycle, two-cylinder, low speed, marine type gasoline engine. The generator is direct current, has a rated capacity of 175 amp., and a maximum capacity of 225 amp., at 1750 r.p.m. The generator is designed to operate at arc voltage, and inherently to stabilize the arc and supply a substantially constant current of different values over the working range of 90 to 225 amp. The operating characteristics of the generator are such that it is unusually easy for the operator to strike and maintain the arc, and also to obtain the deep penetration and thorough fusion necessary for satisfactory welding. The shaft of the generator extends through the pedestal bearing and is connected by means of a flexible coupling to the exciter.

The engine is of rugged construction throughout, the cylinder block and removable head being of semi-steel. The valves, main bearings, and connecting rod bearings are all of liberal dimensions for the service. Other features of the engine are forced feed system of lubrication, Wheeler-Schebler carburetor, Taco throttle governor, impulse starter and large honeycomb type radiator.

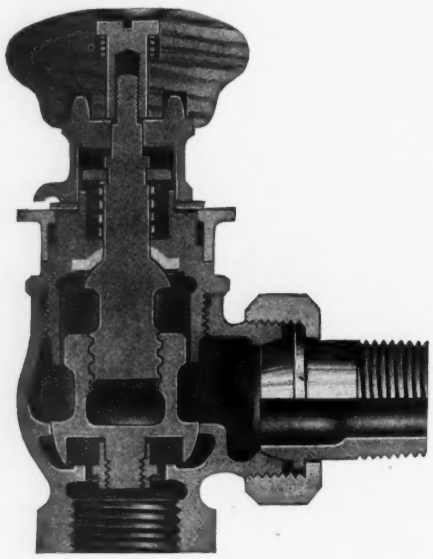


GASOLINE ENGINE DRIVEN WELDING SET

The control panel is mounted directly over the generator on a rigid, light weight angle iron frame work, and the entire equipment is mounted on a substantial cast-iron bedplate.

Packless Radiator Valve

A NEW steam radiator valve recently placed on the market by the Ohio Brass Co. is shown in the accompanying figure. The stem is non-rising and is provided with a spherical shoulder which bears



SECTION OF PACKLESS RADIATOR VALVE

on a special metal rolled in the body of the center piece. This metal to metal contact which is maintained by a heavy spring, provides steam tightness. The valve proper runs on guides in the center piece and is fitted with threads that engage with the valve stem.

The valve seats in a double seat; the lower one on which the composition disc seats provides steam tightness when closed; the upper one, by reason of the varying diameter of the disc holder, permits of accurate fractional opening of the valve to pass any desired amount of steam. A graduated dial on the cap may be set for any desired maximum opening, as determined by experiment, for the particular radiator it is to serve.

New Types of Control Relays

THE General Electric Co. has recently developed two new control relays of the plunger type, known as the PB-53, instantaneous, and the PB-54, hesitating. They are designed for the control of any solenoid operated circuit breaker which requires current greater than can be handled by a control switch.

The two relays are of somewhat similar construction and operation, both being made from standard punched parts. The contacts of both are provided with blowout coils to facilitate opening, and to prevent un-

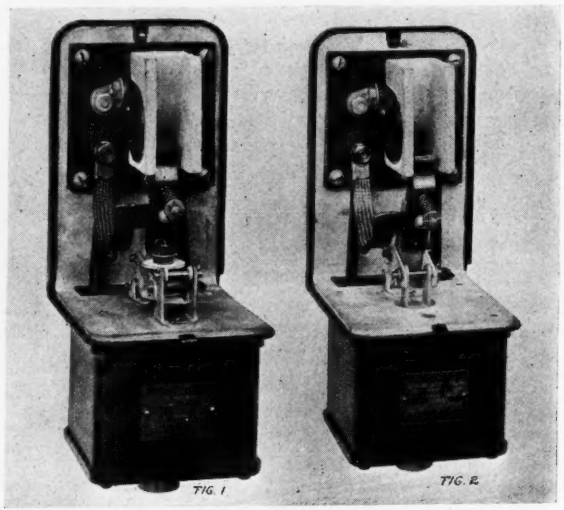


FIG. 1. TYPE PB-54 HESITATING CONTROL RELAY
FIG. 2. TYPE PB-53 INSTANTANEOUS SOLENOID RELAY

necessary burning at the tips. In the PB-54 the contacts are closed by a toggle mechanism, and in the PB-53 by a bell crank actuated by a plunger.

The hesitating feature of the PB-54 is obtained by the inductive effect of a heavy copper short-circuited coil, or winding, located in the spool. The effect of the winding is to retard the reduction of the flux when the relay coil is de-energized, thus delaying the drop of the plunger about a second after current is taken off the coil.

In practice, these relays, which are circuit closing, controlling one circuit, have their operating coil connected across the operating bus in series with the control switch, and their contacts in series with the closing coil of the oil circuit breaker. Since the relay operating current is small, the only heavy leads necessary are those between the relay contacts and the solenoid.

Carbon Tetrachloride for Extinguishing Electric Fires

IN ITS REPORT on the effect of Pyrene (carbon tetrachloride), in the New York Subway fire, the Transit Commission states that the smoke and fumes were principally from burning insulation, paint and other organic matter; that the vapors and fumes from the carbon tetrachlodire were so diluted due to drafts about the fire as to be negligble, and there is no evidence that poisonous gas was generated from that source; that no substitute has been found which is as good or better as a fire extinguisher; that sand or a powdered substance is impracticable where apparatus is hung on a vertical wall, underneath a car floor, or from a ceiling; and that passengers affected by the smoke showed no signs of poisoning other than that of smoke from ordinary fires.

In the investigation, the Commission had the assistance of Messrs. Gibbs & Hill, consulting electrical engineers, and of experts from the Federal Bureau of Mines, sent at the Commission's request.

Train crews who were actively engaged in fighting the fire, at a few feet from it and who remained in the tunnel until all passengers had been removed showed no symptoms of poisoning by phosgene gas; nor does study of the symptoms of passengers as shown by hospital charts show any such effect.

Nothing has been discovered by the closest investigation to justify the discontinuance of carbon tetrachloride as a fire extinguisher for electric fires, and the Commission has directed the Interboro to continue it as heretofore.

News Notes

COL. H. M. BYLLESBY of H. M. Byllesby & Co., consulting engineers of Chicago, was recently presented with the United States distinguished service medal by Maj.-Gen. George Bell, commanding the sixth corp area, for "exceptionally meritorious and distinguished services." The citation states that as general purchasing agent for the A. E. F. he displayed great energy, a comprehensive knowledge of large business affairs, and executive ability of the highest order, and solved problems of fuel supply with conspicuous success in a manner which insured at critical times a plentiful coal supply both for our transport service and our troops in France.

THE FRANKLIN TRUST CO., of Loveland, Colo., representing the Western Light and Power Co., the present producers of power and light for the city of Loveland, Colorado, have thrown a wrench in the cogs of the hydroelectric power plant proponents. In the District Court of Denver, an injunction has been asked enjoining the mayor and council of Loveland from accepting any bids for the construction of a power plant, transmission and distributing system, on the ground that the authorized bonded debt of the city cannot exceed, by law, the sum of $128,000.

An ordinance passed by the council in July, 1922, authorizes the issuance of $300,000 worth of revenue bonds, for the construction of the proposed light and power plant, to be run in opposition to the Western Light and Power Co. This bond issue is in addition to another one for $128,000 authorized previously, according to the plaintiff. It is further contended that the establishment of a municipal system will interfere with the earnings of the Western Light and Power Co., which is unable to pay dividends upon its common stock because of the close margin of profit.

If the hydroelectric plant is built it will be on the Big Thompson River, a site within a short distance of Loveland.

CHANGES AFFECTING the personnel of the Atlanta, Denver, Seattle and New Orleans offices have been announced by officials of the Westinghouse Electric & Manufacturing Company.

In the Atlanta office, R. H. Moore has been appointed office manager and Thomas Fuller has been made manager of the Central Station division and has been placed in charge of the sale of supply apparatus.

E. C. Means has been appointed manager of the Central Station and Transportation divisions of the Denver office and J. P. Sprunt, Jr., has been made manager of the Merchandising division, which was recently organized there.

J. G. Miles has been appointed manager of the Central Station division and has been placed in general charge of the sale of supply apparatus in the Seattle district. A. W. Eshelby has been appointed manager of the Transportation division and A. A. Miller has been made special representative in large negotiations and power developments in the Seattle office.

O. P. McCord has been appointed branch manager of the New Orleans office.

CELITE PRODUCTS, LIMITED, has been established in Canada to market Sil-O-Cel and Filter-Cel as produced by the Celite Co. in the United States. Stocks of these materials will be maintained in Montreal. Lawrence Russel has been appointed manager with offices in the New Birks Building.

FRANK ROLANDI has just about completed his big tunnel contract with the Pacific Gas & Electric Co. near Fall River Mills. The tunnel, 10,160 ft. in length, has been cement lined throughout and in two weeks or less it will be ready for the water from Fall River. Very nearly the entire stream will be sent through the tunnel and into the penstocks leading to the power house at Pit No. 1.

THE COLORADO ENGINEERING COUNCIL has donated to the Public Library of Denver, Colo., a $12,000 available fund, 3000 technical books and the creation of an annual fund of from $2500 to $4000 for the upkeep and enlargement of this library.

IN THE financial and oil districts of Denver, it is admitted that from reliable sources the information is obtained that owing to the coal strike many industrial concerns in Chicago and Kansas City are placing orders for fuel oil, the price of the oil jumping from 90 cents a barrel to $1.15.

THE DIRECTORS of the Turlock Irrigation district in California opened seventeen bids recently for the supply of material and labor for the construction and maintenance of the electrical works to be built at Turlock to distribute the power from the Don Pedro Dam, which

the people recently voted to retain instead of selling to a power company. The bids were for the supply of machinery, line, poles, electrical equipment and labor.

ARTHUR WARD FOX, formerly secretary and assistant treasurer, has been elected to the office of vice-president and general manager of the Johns-Pratt Co., Hartford, Conn. Mr. Fox has been associated with this company for 16 yr., starting as a clerk and working up through the various departments, becoming assistant treasurer and factory manager and later secretary.

JOHN T. SIMMONS has become sales manager for the New Brunswick Iron Works, of New Brunswick, N. J., which has recently purchased the Worthington Water Tube Boiler Co., of New York. A New York office will be maintained at 145 West 38th St.

THE LARGEST high tension electric switches ever built are now being installed by the Pacific Gas & Electric Co. in its Pit River hydroelectric development. These switches, six in number, weigh upwards of 30 T. each and are nearly 18 ft. high. Approximately 2000 gal. of oil are required for each switch.

The switches were specially built by the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, and are being installed at both ends of the 220,000-v. line now under construction by the P. G. & E. through the upper Sacramento valley. Three switches will be placed in service at Pit No. 1 power house in Shasta County and three at the company's Vaca substation, near Dixon.

While the switches were designed to operate on a 220,000-v. system, they have been subjected to a test of 350,000 v., over 50 per cent higher than the normal operating voltage. In addition to being the largest in actual size, the switches are also constructed to break the highest voltage current ever utilized in a commercial way.

CONSOLIDATION is announced of the Automatic Carbonic Co. of Peoria, Ill., with the Norwalk Iron Works of So. Norwalk, Conn.

BRUNSWICK REFRIGERATING Co., New Brunswick, N. J., has acquired the CO_2 refrigerating machinery department of Kroeschell Bros. of Chicago.

U. S. CIVIL SERVICE COMMISSION announces an examination for assistant examiner, Patent Office, Oct. 18, 19 and 20, to fill vacancies in the Patent Office, Washington, D. C., at the entrance salary of $1500 a year, with the bonus granted by Congress of $20 a month to appointees whose services are satisfactory, with the provision for promotion to positions paying from $1650 to $3900 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries. Competitors will be rated on mathematics, physics, mechanical drawings, language, technics, and an optional subject from a given list. Applicants must have reached their twentieth but not their seventieth birthday on the date of the examination. In view of the retirement act, should the appointing officer so request certification will not be made of eligibles who have reached their fifty-fifth birthday. Apply for Form 1312, stating examination title.

U. S. CIVIL SERVICE COMMISSION announces examinations for junior engineer, junior physicist, and junior technologist on Nov. 22, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at $1200 to $1500 a year, and in positions requiring similar qualifications, at these or higher or lower salaries. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month. Applicants must not have reached their thirty-fifth birthday on the date of examination. This age limit does not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Catalog Notes and Book Reviews

BULLETIN No. 294, recently issued by the B. F. Sturtevant Co., of Hyde Park, Boston, Mass., describes the Sturtevant stoker. This is an underfeed stoker with a centrally located horizontal retort extending longitudinally through the furnace. It is designed to burn any grade of bituminous or semi-bituminous coal or any mixture having sufficient coking qualities to bind the fuel.

"ELECTRICAL HEATING Reference Data" is the title of a 12-page bulletin recently issued by The Electrical Alloy Co., Morristown, N. J. This bulletin contains much valuable information useful to the engineer designing electrical heating elements and also includes a number of charts showing the current carrying capacity and other characteristics of resistance ribbon and strip. Suggestions to the engineer as to the correct use of the data are given together with a discussion regarding the proper selection of material.

CONDULETS, 714-page catalog No. 2000 of the Crouse-Hinds Co., of Syracuse, N. Y., has been issued. It has been carefully compiled to present in a comprehensive manner the numerous conduit fixtures and devices manufactured by this company.

BULLETIN 44,015, issued by the General Electric Co., Schenectady, N. Y., describes safety car equipment. The standard safety car is approximately 28 ft. in length, seats 32 passengers, and is mounted on a single truck. It is driven by two 25-hp. railway motors.

THE JOHN STEPTOE Co., Cincinnati, O., has issued a leaflet describing the Standard Engine Lathe, which it has added to its line.

PULVERIZED FUEL Equipment is the subject of Bulletin A, just issued by Quigley Fuel System, Inc., 26 Cortlandt St., New York City. This bulletin gives a condensed description of Quigley appliances for preparing, distributing and burning powdered coal. The layout of a typical coal milling plant is shown and the methods of distribution and control are described.

IN BULLETIN 622 the Esterline-Angus Co., of Indianapolis, Ind., announces the development of a graphic voltmeter which operates equally well on alternating and direct current. A companion instrument, known as the "Utility" wattmeter, is also described in this bulletin, and like the voltmeter is accurate on both alternating and direct current circuits. It is used, largely, for survey purposes.

THE WESTINGHOUSE Electric & Manufacturing Co., East Pittsburgh, Pa., is distributing Publication 4249-A, describing its line of insulating and soldering compounds. Some of the materials treated in the publication are baking varnishes, air-drying varnishes, insulating compounds, finishing materials, insulating glue, soldering flux, and lubricating oil.

THE LOCOMOTIVE REVOLVING CRANE, on account of its flexibility of application, has in the past ten years come into use to an extent not fully realized. Starting with the crawler crane as the smallest element in the development of what might be called the locomotive revolving crane family, the next larger type is represented by what is known as the standard gage crane, which travels on any track that a railroad car will negotiate. All types are both cranes and locomotives, often replacing and obviating the necessity of maintaining a switching locomotive or switching service. To meet the larger and more extensive problems, what is known as the wide gage crane has been developed; gages vary from standard to 20 ft. and upwards, the maximum radius of handling loads of any desired weight varying up to 125 ft.

The new Link-Belt catalog, Book No. 567, is replete with interesting illustrations showing at a glance how money can be saved and material of all kinds expeditiously handled by the use of cranes of all tyes and dimensions and is well worthy of a place in the library of everyone interested in the problem of material handling.

THE YARNALL-WARING Co., Chestnut Hill, Philadelphia, has recently issued a catalog on its new Yarway steam trap. This trap is of the bucket type and is fitted with automatic ball valves. The construction is rugged and simple and there are but two moving elements, the bucket and the balls. This catalog may be obtained by anyone interested, by communicating with the company.

BULLETIN No. 47606 describing relays and their operation and general application has recently been published by the General Electric Co. A table of application of standard relays in the back of the bulletin will assist in obtaining a general idea of the different types and applications of the more common relays.

PENNSYLVANIA PUMP & COMPRESSOR Co., Easton, Pa., has issued a new 16-page bulletin describing the company's line of double suction single stage centrifugal pumps and containing useful engineering data.

THE HOPE Engineering and Supply Co., of Mt. Vernon, Ohio, has issued an attractive 20-page illustrated booklet, describing the activities of this organization in the natural gas and petroleum field.

THE HYDRAULIC SOCIETY has gotten out a second edition of its pamphlet entitled "Trade Standards in the Pump Industry."

This edition contains some additional tables and explanatory data, and also a revised list of members of the society.

Copies may be secured from the members or the Secretary, C. H. Rohrbach, 50 Church St., New York, and if desired in quantities, will be supplied at cost of printing.

THE CAR wheel is one of the important factors which have made possible the great development of transportation facilities that has occurred within the past seventy years. Although during this time many types of car wheels have been utilized, only five have come into common use—namely, the rolled steel wheel, the forged steel wheel, the cast-steel wheel, the built-up wheel, and the chilled iron wheel. Of these wheels, the relative cheapness of the last, together with certain other advantages they possess, makes the use of the chilled iron wheel almost universal in freight service.

Owing to the desirability of obtaining definite information concerning the magnitude and distribution of stresses in chilled car wheels and of determining the limits of these wheels as used today, and with a further view of improving the chilled iron wheel in order to meet future requirements, a co-operative investigation was entered into by the Association of Manufacturers of Chilled Car Wheels and the University of Illinois. Bulletin 129 of the Engineering Experiment Station of the University of Illinois presents the results of the first part of this investigation, that is, the results of tests made to determine strains produced within the wheel by mounting it on its axle, and by the application of wheel loads. The bulletin includes a discussion of the general problem of wheel loading, the determination of the physical properties of chilled car wheel irons, a description of the apparatus and methods used in the tests, and a general summary of the conclusions to be drawn therefrom.

GRAY SYSTEM for economical boiler plant operation is discussed in a new catalog from Automatic Fuel Saving Co., Philadelphia, Pa., the principle of the system remaining the same as heretofore. The catalog, however, describes some mechanical changes in the company's furnace air controller and steam controller.

A PAMPHLET illustrating and describing the Schoop metal coating process for simultaneously melting and atomizing any of the commercial metals, either in wire or dust form, and impacting them on any surface, was lately received from Metals Coating Co. of America, Philadelphia, Pa.

IN ORDER to show the feasibility of applying electric motors for driving pumps of all kinds and to point out the considerations involved in selecting the best type and construction of motor and control for different installations, the General Electric Co. has prepared a 60-page bulletin, No. 48,028, entitled "Electrically Operated Pumps."

THE WESTINGHOUSE Electric & Manufacturing Co., East Pittsburgh, Pa., has just completed the preparation of a 64-page illustrated publication on mining apparatus. In addition to line material, the publication, which is known as Catalog 6-M, contains much information about mine safety switches, Frankel solderless connectors, tapes, babbits, solders, micarta gears, mine locomotives and mine locomotive headlights.

CATALOG No. 10 recently issued by the Central Station Steam Co., Detroit, Mich., is descriptive of the new Cadillac condensation meter. This is a volumetric measuring device for accurately and continuously recording the quantity of steam used for heating or

other purposes. It is an improved design of the Detroit condensation meter also manufactured by this company.

THE BUDD GRATE CO., 2011 East Adams St., Philadelphia, has issued two interesting bulletins, entitled "Smokeless Combustion" and "The Budd Combustion Arch System."

THE JOS. W. HAYS CORPORATION, Michigan City, Ind., has recently issued two interesting pieces of literature, one a leaflet describing "Bestix" asbestos boiler setting cement and the other a booklet of operating instructions for the Hays Automatic CO_2 and Draft Recorder. The latter is an attractive 32-page booklet, containing numerous diagrams and photographic illustrations, showing the principle of action and the constructional features of the Hays recorder.

THE MCALEAR MFG. CO., 1901 South Western Ave., Chicago, Ill., has just issued a 128-page catalog, known as No. 27, which illustrates many new devices, including an individual temperature control valve, specialties for all power plants, vacuum and vapor heating systems, oil refining and water works plants, plumbing systems and marine service, together with illustrations showing their application and use.

CATALOG M of The Reliance Gauge Column Co., Cleveland, O., deals with Reliance steam specialties, including Reliance safety water columns, electric alarms for water columns, seamless copper floats, water gages, gage cocks and steam traps.

LEAFLET No. 3428, recently issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is devoted to a description of rolling contacts for electrical control apparatus. Rolling contacts consist of two identical L shaped pieces, the contact surface of the L's being bent into a curve. As the contacts approach, they engage at the tips or outer edges of the curves and roll down to the heel, or portion next to the angle. Thus the burning at both closing and opening takes place at the tip of the contact away from the current carrying parts. The current is carried at the heel of the contact, which is subjected to the maximum spring pressure and is kept clean by a slight sliding action during the closing period, and a good current carrying capacity is therefore assured.

BULLETIN No. 3 of the McAleenan Corporation, Pittsburgh, Pa., discusses the McAleenan water-tube boiler which is built of any capacity from the smallest water-tube unit up to 1500 rated horsepower, and for any pressure up to 350 lb.

A NEW FOLDER entitled "A Neglected Source of Economy," which deals with the savings that can be effected in manufacturing plants by the use of refrigerated drinking water systems, has been received from Armstrong Cork & Insulation Co., Pittsburgh, Pa.

ALLIS-CHALMERS MANUFACTURING CO.'S new bulletin No. 1124, entitled "Synchronous Motors," contains many illustrations of this type of motor in the various industrial applications, and as used for belted, coupled or direct connected service, these motors being used for driving air compressors, motor generator sets, also for rubber mill drive, flour mill drive, ice making machinery, ice and refrigerating machinery, paper making machinery and for driving mine fans, pumps, etc.

Bulletin No. 1122 from the same company covers steam turbine and generator units of the condensing and non-condensing type with pressure operated bypass valve, these units being used for sugar mills, refineries, sawmills, power and manufacturing plants.

BULLETINS have been received from engineering department, National Lamp Works of General Electric Co., Cleveland, Ohio, as follows: Bulletin 45—Lighting Designs for Stores, and Bulletin 47—Better Electric Lighting in the Home.

AN AUTOMATIC load regulator designed to correct the fluctuating load conditions of motor-driven pulp grinders, is described in Leaflet No. 1934, issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

WEAR TESTS OF CONCRETE by Duff A. Abrams, a 24-page bulletin (No. 10) issued by the Lewis Institute of Chicago, is a report on a series of tests on concrete blocks of varying composition to determine a relation between the amount of wear, produced under similar conditions, the composition, strength and amount of seasoning or curing. A number of charts are given showing these various relations in graphical form. Equations are derived from the graphs so that these relations may be determined for specimens not covered by the test.

QUANTITIES OF MATERIALS FOR CONCRETE by D. A. Abrams and Stanton Walker, 21-page pamphlet, Chicago, 1922.

This bulletin (No. 9) issued by the Lewis Institute of Chicago on the proportion and quantities of materials used in the production of concrete of various compression strengths, is a compilation of tables showing proportions and quantities of materials using fine and coarse aggregates of different sizes for concrete mixtures capable of withstanding pressures of from 1500 to 4000 lb. per sq. in. Directions for using the tables and methods of conducting tests are given.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, edited by Frank F. Fowles; size, 4 by 7 in., 2139 pages; New York, 1922.

This, the fifth edition of this work, has been revised to embody the latest developments of electrical engineering. Since the last revision in 1915, electrical engineering has made rapid advance and a new edition was found necessary to keep abreast of the profession.

The book comprises 25 sections written by more than 60 leading electrical engineers. It is exceptionally well indexed so that any desired information may be readily located.

Sections included are units, conversion factors and tables; electric and magnetic circuits; measurements and measuring apparatus; properties of materials; magnets; induction coils, condensers, and resistors; transformers and rectifiers; a.c. and d.c. generators and motors; converters and double current generators; power plants; power transmission; distribution systems; interior wiring; illumination; industrial motor applications; electric railways; electric vehicles; electric ship propulsion; electric chemistry; batteries; telephony, telegraphy and radio telegraphy; miscellaneous applications; mechanical section; standards of the A. I. E. E.; and engineering and central station economics.